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Engineering Student Positionality and Alignment with The Culture of Disengagement

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ABSTRACT

The culture of disengagement, consisting of meritocracy, depoliticization, and technical/social dualism, is an ideology that has been connected to decreasing interest in public welfare among engineering students. These mindsets present a barrier to engineering for social justice. This paper aims to examine how aspects of positionality such as gender and ethnicity may impact students' alignment with the culture of disengagement, to better inform interventions. Pre- and post-term surveys were completed by students in the third mandatory engineering design course at the University of Guelph, Canada. Regressions were run on several closed-ended questions, while coding and thematic analysis were conducted on open-ended questions. Results show significant gender differences in all three pillars of the culture of disengagement, with men having a stronger alignment with the culture of disengagement than women and nonbinary students. Mixed relationships between students' lived experiences on their beliefs were found. Students' ideology, and their engagement with social justice, can be deeply informed by their positionality. Recommendations include tailoring interventions based on program stream where there are large variations in gender balance and/or providing flexibility in the level and content of students' social justice learning.

KEYWORDS

Student ideology, Social justice beliefs, Meritocracy, Depoliticization, Social/technical dualism

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Introduction

Considering the social implications of engineering work is often emphasized as crucial in tackling wicked problems such as the UN sustainable development goals (UN, 2026) and appears accordingly within legislature governing the profession. For example, according to the

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Code of Ethics from Ontario's Professional Engineers Act, the "paramount duty" of engineers is their duty to safeguard public welfare (Professional Engineers Act, 1990). However, this duty is often only considered within a limited scope, such as the safety of a design for the intended end user, instead of considering the design's broader impacts on society. Engineering for social justice (E4SJ) aims to equitably distribute benefits, such as opportunities and resources, while minimizing harm created through the process of engineering (Lucena & Leydens, 2018). Certain ideologies and mindsets can present barriers to engaging with E4SJ. This includes the culture of disengagement outlined in (Cech, 2014). The culture of disengagement has been connected to decreasing interest in public welfare among engineering students as they progress through their degree and enter the workforce.

This paper aims to examine how engineering students' alignment with the culture of disengagement may be informed by their positionality, such as their gender or ethnicity.

Positionality Statement

The first author, Qurat-ul-ain Dar, is an able-bodied South Asian 1.5-generation immigrant settler. She completed the University of Guelph's undergraduate Environmental Engineering program in 2021 and a Master of Applied Science in Engineering at the University of Guelph in 2023, conducting this research as part of her master's thesis. She took ENGG*3100 (the course of interest in this study) in the Winter 2020 offering, initially in-person but remotely the last few weeks due to the initial COVID-19 lockdown. Qurat-ul-ain had a mix of in-person, online, and hybrid learning throughout her undergraduate and graduate studies. She worked alongside a biology undergraduate student in coding the data but was the primary lead in the analysis and guided code generation. Her experiences at the University of Guelph in the engineering program informed her interpretation of the data, including her own experiences with the culture of disengagement.

The second author, Dr. Julie Vale, is a straight, white, cisgender, settler woman in an engineering field that is traditionally heavily male-dominated. She has prior experience with engineering pedagogy research in social justice-adjacent projects with value-based outcomes and provided background knowledge and guidance on analysis. She is a faculty member in the College of Engineering at the University of Guelph who had no involvement with ENGG*3100 in Winter 2022 (the data collection period).

The third author, Dr. Andrea Bradford, is a white settler woman who has been a faculty member in water resources engineering at the University of Guelph for more than 20 years and was one of the course instructors of ENGG*3100 in the Winter 2022 offering. To avoid the influence of instructor-student power dynamics and to follow research ethics best practices, the first author (Qurat-ul-ain) administered the surveys, announced the study in class, and was the only one with access to identified survey data including which students did or did not consent to participate in the study. Qurat-ul-ain had no involvement in ENGG*3100 besides this research.

Background

The following sections provide background from the literature on how positionality may affect mindsets associated with the culture of disengagement which consists of three pillars: depoliticization, technical/social dualism, and meritocracy. Cech's study found minimal variation in the public welfare beliefs of engineering students based on gender and ethnicity A few other studies have examined the presence of the culture of disengagement, with mixed results. Bielefeldt and Canney found over a three-year study most engineering students (57%)

did not change in their beliefs on social responsibility, with smaller groups of students with increasing (20%) or decreasing (23%) senses of social responsibility (Bielefeldt & Canney, 2016). A study of interviews with engineering students over a four-year period found that their sense of social responsibility shifted towards a focus on aspects such as safety and the general betterment of society, with less of a focus on improving the lives of the disadvantaged (Rulifson & Bielefeldt, 2019). A case study of an engineering student's beliefs over the course of his degree found shifts from idealism to pragmatism, lower commitment to public engagement, and a higher level of moral disengagement (Claussen et al., 2021). However, these studies focused on students' social responsibility instead of the pillars of the culture of disengagement directly (meritocracy, depoliticization, technical/social dualism) which may be informing their sense of social responsibility. Research attempting to characterize engineering students' alignment with the pillars themselves would provide a stronger understanding of the culture of disengagement. Scholars have identified the importance of examining these ideologies more deeply in the context of engineering education (Schiff et al., 2021).

An outcome of Cech's study was her identification of three pillars contributing to the culture of disengagement: meritocracy, sociotechnical dualism, and depoliticization, but her study design did not assess those pillars of the culture of disengagement directly (such as by attempting to measure meritocratic belief) (Cech, 2014). Here, we dig deeper into each of those three pillars.

Meritocracy is an ideology describing the relationship between hard work and success. Descriptive meritocracy specifically involves the belief that existing systems are meritocratic, or that success is a product of hard work, and failure due to a lack of effort (Zimmerman & Reyna, 2013).

Equity-deserving groups may reproduce meritocratic beliefs as a coping mechanism for existing within an unmeritocratic system, or as a means of aligning themselves with more privileged groups (Fernández et al., 2022). Meritocratic belief may have potential psychological benefits, especially for those within equity-deserving groups, due to a perceived sense of control over one's circumstances and potential for future success regardless of their personal history (Hu et al., 2020). However, these benefits may be limited – according to the "underdog thesis," those within equity-deserving groups are more likely to question ideologies such as meritocracy due to their own unmeritocratic experiences that contradict them (Xian & Reynolds, 2017). Further, the disparity between the ideology of meritocracy and how their own efforts and hard work are (not) rewarded can lead to psychological stress (Garrison et al., 2021).

The interactions of gender and social position can shape meritocratic beliefs in several ways. Women who perceive their workplace as unmeritocratic through the existence of barriers for women to attain senior leadership roles (a "glass ceiling") may lose hope in their workplace and be less likely to engage in working to improve the organization outside of their role and more likely to leave the organization (Javadizadeh et al., 2022). Women who are more likely to encounter gender barriers within their work have been found to recognize the structural reasons for gender inequality in Science, Technology, Engineering and Math (STEM) more than those who attained a top role in their organization, who are "most invested in seeing the system as fair" (Cech & Blair-Loy, 2010). However, women experiencing unemployment, underemployment, and even houselessness, may adopt strong meritocratic beliefs to maintain a sense of hope that individual efforts may help them escape poverty (Kozan et al., 2019).

Female engineering students, while recognizing and criticizing the sexism they face, may rationalize it through meritocracy, turning "potential critics into agents of cultural reproduction" (Seron et al., 2018). For example, while recognizing the small number of women in engineering, they may justify their own place through the lens of exceptional ability and hard work, or dismiss their own struggles within engineering (which may have systemic roots) as the result of their perceived inadequacy (Seron et al., 2018). Similarly, within the engineering workforce women from various backgrounds may accept discrimination and bias by attributing it to meritocratic reasons (Turpen et al., 2019).

An individual's ethnicity may play a role in their meritocratic beliefs as well. This may be through internalized stereotypes, such as the model minority myth. The model minority myth is a series of stereotypes that frames Asian immigrants as the "epitome of assimilation" within their host society, through traits such as extreme intelligence (especially in STEM), strong work ethic, high educational and financial achievement, and a passive acceptance of inequity (Trytten et al., 2012). This myth was created and perpetuated to maintain white supremacy by undermining racial solidarity between Asians and members of other Black, Indigenous, and/or People of Colour (BIPOC) communities (McGee, 2018; Trytten et al., 2012). The model minority myth points to high-achieving Asians as proof that society is indeed meritocratic and assumes anyone less successful is due to personal deficiency instead of systemic barriers (Sampat, 2022). Asian students may feel a pressure to conform to these stereotypes, while students who face negative stereotypes about their school performance due to their ethnicity (such as Black students) may feel pressured to prove them wrong (McGee, 2018).

The role of ethnicity in meritocratic belief is particularly relevant due to the recent U.S. Supreme Court ruling against affirmative action policies in university admissions (Panetta, 2023). While the case was spearheaded by white conservative Ed Blum, many of the students speaking against affirmative action in the media were Asian (Dirks, 2023). A view of diversity initiatives as a threat to true meritocracy may intersect with the model minority myth in insidious ways, undermining solidarity between students of colour.

Another possible interaction between ethnicity and meritocratic belief is John Henryism. John Henryism is an active coping mechanism prevalent among Black Americans that involves exerting high effort in response to stressors such as structural racism, in the hope of exerting some control over one's environment (Perez et al., 2023; Robinson & Thomas Tobin, 2021). This mindset is informed by meritocratic belief, championing hard work as a way to overcome one's circumstances. However, John Henryism and meritocratic beliefs may even have health implications – a study found high levels of discrimination experienced by Black individuals with strong meritocratic beliefs was associated with higher blood pressure and a greater number of chronic illnesses than among those with weak meritocratic belief experiencing discrimination (Hagiwara et al., 2015).

Technical/social dualism is a mindset that involves the separation of technical and social competencies, often considering the technical as more valuable than the social (Cech, 2014). An individual with this mindset can perceive engineering as a purely technical field as opposed to a sociotechnical one. Technical/social dualism has gendered connotations considering the historical association of "social" dimensions with femininity and "technical" dimensions with masculinity (Faulkner, 2007). Female engineering students have been found to place a greater importance on the social and ethical dimensions of engineering, and a greater value on sociotechnical skills, than male engineering students (Swartz & Leydens, 2019). A recent

scoping review (Rodrigues & Seniuk Cicek, 2024) provides an excellent overview of sociotechnical thinking in engineering education.

Depoliticization is the perception of "pure engineering" as something that can and should be separate from social and political concerns (Cech, 2014). Gender may have similar effects upon this mindset as for technical/social dualism, as in (Swartz & Leydens, 2019) it was also found that female students were more likely to recognize engineers' social responsibility to the public and the possibility for positive or negative impacts of their work on individuals and communities. Ethnic and/or cultural background may inform students' tendency towards individualist or collectivist thinking, which could in turn inform their sense of social responsibility and their motivation for engaging in prosocial behaviour such as volunteering (Finkelstein, 2011). The diversity of the overall community may also have an impact, with (McCann, 2022) finding more racially and ethnically diverse American states were more collectivist and less individualistic.

Methods

This multimethod study used an embedded, exploratory design. In embedded design, a second method incorporated within the first serves to improve the overall design (Schoonenboom & Johnson, 2017). Quantitative and qualitative data was largely gathered concurrently through pre- and post-term surveys (Qualtrics) with closed and open-ended questions. Semistructured student interviews provided a smaller, sequential source of qualitative data. Quantitative results were used to characterize the overall cohort and broader patterns, while qualitative results provided insight at the student level.

Course Context and E4SJ Interventions

ENGG*3100 is the third mandatory engineering design course at the University of Guelph. The focus of the course is an open-ended design project that students complete in groups of four or five, with a series of associated deliverables, such as reports and memos, and a final presentation. Students choose their design problem and have regular feedback from professors and teaching assistants on their project during lab periods. The course has no final exams or test-based assessments. Lectures cover content that support the design project such as problem definition, project management, life cycle assessment, and teamwork. ENGG*3100 is generally taken by students in all engineering disciplines in their sixth academic semester (of eight).

A series of interventions for E4SJ were included throughout the course in Winter 2022. This included activities focused on positionality, beginning with a short module presented in class on topics such as privilege and bias in Week 2. Students were then given a take-home workbook on positionality, and in a subsequent lab filled out a positionality radar worksheet with their design team. In Week 4, students worked in breakout rooms of four or five to brainstorm the consequences of major innovations, positive or negative, intended or unintended, on Google Jamboards. The topic for the Week 10 lecture was E4SJ and included considerations of which stakeholders may be centered or left out of problem definition, as well as introducing approaches such as social life cycle analysis and contextual listening that can support E4SJ. Four questions within students' final reflections asked them to consider aspects of social justice and stakeholder engagement within the context of their design project.

Due to the COVID-19 pandemic, students in this offering of ENGG*3100 would have experienced most of their undergraduate degree either online or in a hybrid format. In Winter 2022, the first three weeks of the semester were held online in response to a surge of the

Omicron variant. A team of five instructors from Engineering at the University of Guelph taught the course, with support from eight teaching assistants. From the five instructors in Winter 2022, four were men and one a woman. Two of the five instructors were people of colour. There were 282 students in the course, 185 who participated in the research. Completing the pre- and post-term surveys associated with this study was required to avoid a mark penalty, but participating in the research was voluntary.

The engineering program streams offered at the University of Guelph are mechanical, biomedical, biological, environmental, water resources, computer, and systems and computing. There are co-op (5 year) and non-co-op (4 year) options for each program. Third- and fourth-year engineering courses generally have a mix of co-op and non-co-op students, as the first co-op term takes place after the completion of second year. Several first-year courses that engineering students are required to take (such as general science courses) are not exclusive to engineering students. In addition to restricted electives, students take 1.5-2.0 credits of Complementary Studies electives in areas such as the humanities, languages, or economics. Engineering students across disciplines take four mandatory engineering design courses (including ENGG*3100) which focus on group design projects and can choose to work in groups with a mix of engineering disciplines. These design courses have a higher credit weight (0.75 or 1 credit) than most undergraduate engineering courses (0.5 credit) at University of Guelph. However, perhaps due in part to a lack of test-based assessments, attendance for design lectures tends to be lower than other engineering courses.

Participant demographics

Demographics were only collected in the pre-term survey, and 17 students only completed the post-term survey (and one partial response to the pre-term survey) – these students were excluded from quantitative analysis involving demographics. Those who chose “Prefer not to say” for gender or ethnicity were excluded from the associated regressions, as there are many reasons a student may choose that option. For example, they could feel more comfortable expressing unconventional or extreme views with a greater sense of anonymity in the data or be part of an equity-deserving group and feel uncomfortable disclosing this information.

When collecting gender data, the following options were presented:

- Man
- Woman
- Non-binary
- My gender identity is not listed above (please specify)
- Prefer not to say

When collecting ethnicity data, the following options were presented (respondents could choose multiple):

- Indigenous (Inuit/First Nations/Métis)
- White/European
- Black/African/Caribbean
- Southeast Asian (e.g., Chinese, Japanese, Korean, Vietnamese, Cambodian, Filipino.etc)
- Arab (Saudi Arabian, Palestinian, Iraqi, etc)
- South Asian (East Indian, Sri Lankan, etc)
- Latin American (Costa Rican, Guatemalan, Brazilian, Colombian, etc)

- West Asian (Iranian, Afghani, etc)
- My ethnic background is not listed above (please specify)
- Prefer not to say

These options followed the suggested format from the University of Guelph's Office of Research at the time of survey development.

Demographic data of the study cohort is summarized in Table 1 and is consistent with the overall demographics of the course. Here, nonbinary students were included in the "Prefer not to say" category to avoid presenting identifiable information, as the number of nonbinary students fell below the minimum bin size identified (fewer than five). Similarly, students who chose more than one ethnicity were placed in a "Multiple ethnicities" category as individual responses fell below the minimum bin size and could be identifiable. After those students were categorized, all remaining students were classified as 'individual ethnicities', all of which that fell below the minimum bin size (fewer than five: Indigenous, Black, Latin American) were combined with the "Prefer not to say" category.

Table 1 - Summary of cohort demographics

	Selection	**n**
Gender	Man	106
	Woman	53
	Prefer not to say + nonbinary	8
Ethnicity	Multiple ethnicities	16
	<u>Individual ethnicities</u>	
	Arab	10
	South Asian	11
	Southeast Asian	10
	White/European	107
	Prefer not to say + Indigenous + Black + Latin American	13

Survey

Survey completion was a required course component to avoid a mark penalty, but participation in the research was voluntary. This research was exploratory in nature, intended to examine a range of topics connected to the culture of disengagement and to identify future avenues for investigation and/or intervention. Questions were developed by the research team to address a wide variety of student perceptions relevant to E4SJ, including mindsets associated with the culture of disengagement. A mix of 25 Likert style, 5 yes/no, 2 ranking style, and 14 open-ended questions (46 questions total) were presented in the surveys to gather broader insights into the cohort as well as individual student perceptions. All questions were forced response, including open ended questions.

The research team aimed to create questions that reflect students' context and recent experiences (such as scenarios on grades or admissions) to assess their ideological beliefs in indirect ways, where students may be less likely to self-censor. Four Likert questions were used from the Merit Beliefs Scale in (Zimmerman & Reyna, 2013) to assess prescriptive and descriptive meritocratic beliefs and any discrepancy between them. A series of scenario questions on high school grades and admissions were included to assess student meritocratic beliefs on individual and systemic levels. Questions gathering student opinions of

Complementary Studies electives were intended to address technical/social dualism. Complementary Studies at the University of Guelph are 1.5-2.0 credits that engineering students are required to take from areas such as the social sciences, economics, and the humanities. Depoliticization was incorporated in questions exploring the connection between engineering and social justice. The survey also included general questions on students' understanding of social justice and related topics.

Quantitative analysis

A series of regressions were run in RStudio (2023.03.0 Build 386) upon relevant closed-ended questions using demographics as predictor variables. Ordinal logistic regressions were run on Likert questions and logistic regressions on questions with Yes/No answers.

The power in question responses was assessed before running regressions, following the guidelines for logistic regression that each potential answer should have a minimum of 10 events per regression parameter (Peduzzi et al., 1996). Where required, question responses and demographic data were binned to have sufficient power and avoid overfitting with too many parameters, respectively.

While Likert questions were presented in the survey with 5 options (Strongly disagree to Strongly agree), responses were placed in 3 categories (Disagree, Neither agree nor disagree, Agree) to have sufficient power for regressions.

As logistic regression requires binary answers, questions with Yes/No/Unsure responses were binned, combining "Unsure" with the "No" category. Combining "Unsure" with "No" was intended to be a conservative approach, specific to these questions. For instance, if students were unsure whether social justice was addressed in any of their courses then it may have been presented in an ineffective way or they may be confused about what it means. If they are unsure whether social justice is useful to engineering or struggle to see the engineering connection, then that suggests there is a need for an effective intervention to provide those connections.

While this approach may have resulted in the loss of some detail, even with only 2 or 3 categories, analysis can provide insight to general student perceptions. 26 questions had sufficient power to run regressions, 10 in the pre-term survey and 16 in the post-term survey. 18 of these were Likert questions, 4 Yes/No questions, and 4 Yes/No/Unsure questions.

Most of the Likert questions assessed only had enough power for a regression against one parameter (or a categorical variable with two options). Demographic data was binned accordingly and kept in the same categories throughout analysis for consistency in the results. Regressions were run for one predictor variable (gender or ethnicity) at a time.

Two ethnicity categories were created for regression – "White/European" and "Ethnically Diverse." "Ethnically Diverse" included students who chose any ethnicity besides "White/European." Students who chose "White/European" as well as one or more other ethnicities were placed in the "Ethnically Diverse" category. This is a considerable simplification, as there are complex relationships between ethnic and racial identities. Diversity is a characteristic of groups and not necessarily individuals, but the research team intended to use terminology that would not define this group by centering whiteness (or its absence). The intent was not to erase individual identities and experiences, but to provide an initial characterization of any broad relationships between ethnicity and student perceptions. This categorization was made to recognize the unique experiences of BIPOC students and those with

multiple ethnicities within a mostly white cohort, while working within the limits of the data. Those who chose "Prefer not to say" for ethnicity were excluded from regressions using ethnicity as a predictor variable. "Ethnically Diverse" was used as the reference group during regressions.

Two gender categories were used for regressions – "Man" and "Gender Marginalized," which included women and nonbinary individuals. This was done in recognition of engineering as a historically male-dominated practice where women and those outside the gender binary are systemically excluded. Those who chose "Prefer not to say" for gender were excluded from regressions using gender as a predictor variable. "Gender Marginalized" was the reference group during regressions.

Significant results ($p < 0.05$) were reported within this paper. The proportional odds assumption was checked for ordinal logistic regressions before reporting. Regression coefficients were exponentiated to interpret the results in terms of odds, including 95% confidence intervals.

Qualitative analysis

Inductive qualitative analysis was conducted to gain deeper insight into quantitative results. Open-ended questions in the surveys were analyzed by a team of two researchers, open coding in NVivo 1.7.1 (QSR International). An initial codebook was generated through analyzing a random sample of five survey responses. Intercoder reliability (ICR) was assessed through then double-coding another random 25 surveys and finding Cohen's kappa, a statistical coefficient suitable for nominal data and two coders (Nili et al., 2017), for each proposed code. Twenty-five surveys were used following typical practice of using 10-25% of the dataset to assess ICR (O'Connor & Joffe, 2020). Eleven codes (from a total of 60) that fell below a Cohen's kappa of 0.4 were either eliminated or reworked in discussion between both researchers, following criteria for moderate or better intercoder agreement from (Landis & Koch, 1977). A split-coding phase followed, in which each researcher coded half of the dataset. Researchers met to discuss any emerging codes at the halfway point of split-coding. Once split-coding was complete, 25 random survey responses were double coded to check Cohen's kappa as a final audit. The codebook from the pre-term surveys was used to guide the creation of the post-term survey codebook. From the initial post-survey ICR check, only four codes fell below a Cohen's kappa of 0.4 despite ten additional questions, suggesting that ICR improved through the process of coding the pre-term surveys. Throughout coding, researchers flagged any extreme, unexpected, or unconventional responses for negative case analysis. These cases were examined further and discussed within the research team.

Three supplementary student interviews were conducted, with questions focusing on what students consider important to problem definition and why. Guided by other analyses, transcripts were reviewed for relevant insights. The original aim was to run focus groups of four to five students, but due to a lack of student interest and/or ineffective recruitment methods, the participant pool was too small to do so. They were run instead as individual semi structured interviews. The research team developed interview questions with consideration for interview best practices, as in (Hsiung, 2010). Questions were made general enough to try to avoid leading questions but asked for specific student experiences to gather rich data. Questions prefacing the interview used the scenario of being a hiring manager to provide an initial insight into students' meritocratic beliefs, followed by prompts on the in-school and out-of-school experiences that inform students' understanding of problem definition. Students were recruited for interviews

through posts on the course websites of fourth-year design courses that follow ENGG*3100, so that participants would have been in the Winter 2022 offering of ENGG*3100. This was the only criteria for recruitment, so that students could potentially provide insight to interventions presented in ENGG*3100 and would be nearing completion of their program and have more experiences to reflect upon. Participation was voluntary and interviews were held virtually on Microsoft Teams and recorded. Auto-generated captions from the interview platform were then reviewed for transcription. Due to the small number of interview participants, interview transcripts were not a main focus for analysis, but reviewed for relevant insights into survey results or emerging themes.

Research Ethics

The Research Ethics Board at the University of Guelph provided ethics approval for this study REB# 21-11-003. Consent forms with detailed descriptions of the study were included in the post-term surveys, as well as consent forms provided to interview participants. One of the authors was a course instructor for ENGG*3100 in the Winter 2022 offering. To avoid the influence of instructor-student power dynamics and to follow research ethics best practices, the first author (a graduate student) administered the surveys, announced the study in class, and was the only one with access to identified survey data including which students did or did not consent to participate in the study. The first author was not involved in ENGG*3100 besides this research.

Results

This paper found insights on student perceptions in three main categories – their meritocratic beliefs, technical/social dualism, and general social justice views. Regressions returned significant differences for gender in several questions. No significant results were returned from regressions where ethnicity was the predictor variable – most returned a $p >> 0.1$, with a few results between 0.05 and 0.1. However, qualitative results provided some insight into the potential reasons for these student perspectives.

Meritocracy

Six closed-ended Likert questions in the post-term survey were intended to address meritocratic belief, seen below (the first four from (Zimmerman & Reyna, 2013)):

- People who work hard should achieve success.
- People who work hard do achieve success.
- Anyone who is willing to work hard enough ought to be able to find a decent job.
- Anyone who is willing to work hard enough is able to find a decent job.
- Only using high school grades to make admissions decisions is fair.
- Two students at the same high school with differing socioeconomic status have the same opportunity to achieve good grades.

Ordinal logistic regressions on questions intended to address meritocratic beliefs returned one significant result for gender from the pre-term survey and two from the post-term survey (Table 2). In all cases, the odds ratio shows that men were at least twice as likely to agree or have a neutral opinion regarding the statement as compared to gender marginalized participants.

Table 2 - Significant regression result for gender and merit beliefs. Here, the odds ratio is interpreted as the odds of participants who identified as "Man" being *more* likely to *agree* or have a neutral opinion versus disagree as compared to "Gender marginalized" participants

Statement (Dependent Variable)	Survey	p value	Man likely to agree/neutral		
			Lower 95%	Odds ratio	Upper 95%
Only using high school grades to make admissions decisions is fair.	Pre	0.030	1.07	2.01	3.81
	Post	0.017	1.17	2.20	4.25
Two students at the same high school with differing socioeconomic status have the same opportunity to achieve good grades.	Post	0.000	2.08	4.37	9.92

As seen in Table 2, students in the "Man" category were more likely to have higher agreement with both statements, which were intended to gauge meritocratic belief at the individual (two students) and systemic (admissions) levels. For the question addressing meritocratic belief at the systemic level, there was a significant result for both pre- and post- term surveys, and they were relatively close.

Turning to the qualitative analysis, relevant codes were found from an open-ended question allowing students to comment on their answers to the high school grades scenarios. These included socioeconomic differences, institutional differences, equity/access, and effort and success.

The socioeconomic differences code was determined from student responses that elaborated on the potential role of socioeconomic status in affecting grades. Most of these responses presented a higher socioeconomic status as an advantage in getting higher grades through access to more resources, such as tutors, or fewer obligations (such as working) resulting in more time to study. Representative quotes include:

> *"Students of a lower socioeconomic status may have to work a part time job, not have a quiet place to study at home or have access to internet at home - this would make it much more difficult to achieve good grades"*
>
> *"It is unfair to judge solely on grades, given that different students have different obstacles in front of them to receive good grades. This may be due to personal or family issues, socioeconomic status, or the school system that they are enrolled in."*
>
> *"My family is not wealthy, and come from a lot of trauma (refugees, war). This made me a lot more independent and I had no help from my parents. While my friends were a lot more well off and had successful parents who can help them with assignments, or just everyday things. Because of my socioeconomic class my family had many problems which affected my mental health and ability to show up to classes and perform my best."*

The institutional differences code was determined from student responses that highlighted potential discrepancies between high schools, including the possibility of artificially inflated grades, as in the following:

> *"A single high school teacher can wildly inflate grades to the point they become meaningless. I witnessed this many times in high school"*
>
> *"Additionally, schools is different regions have different curriculums and teachers who may teach different things, or not go into the same detail (leaving others at a clear disadvantage)." [sic]*

The equity/access code describes responses that identified equity or access considerations and socioeconomic status in their answers:

> *"There are many people in this world who do not have the same opportunities. Additionally, students in highschool are very young and influenced by their surroundings indicating that being born in a potetnially unhealthy or unsupportive environment would have a significant impact on their grades." [sic]*
>
> *"Significant life events that affect grades can happen while in high school and grades are not the most important thing in life. For instance, one of my close family members died suddenly when I was in high school and my grades were not a priority during the months following that event."*

The effort and success code was determined from comments on the relationship between hard work and good grades, often placing an emphasis on student drive or motivation:

> *"While the socioeconomic status plays a role, the drive of the individual to succeed and achieve good grades is the deciding factor."*
>
> *"Other factors such as drive and motivation should be considered, but they are hard to quantify"*

Technical/Social dualism

A Likert question followed by a conditional open-ended question on student perceptions of Complementary Studies was intended to address technical/social dualism. If students answered "Yes" to the Likert question, the follow up question asked them to list which Complementary Studies they found relevant or beneficial, and if they responded "No" they were asked why none of the Complementary Studies were relevant or beneficial.

Logistic regressions on the Likert question returned significant results for gender (Table 3). In all cases, men were approximately three times as likely to select "No" as compared to gender marginalized participants, with the odds increasing after the course as opposed to before.

Table 3 - Complementary Studies regression results for gender. Here, the odds ratio is the odds that participants who identified as "Man" will select "No" as compared to "Gender marginalized" participants.

Statement (Dependent Variable)	Survey	p value	Man likely to select "No"		
			Lower 95%	Odds ratio	Upper 95%
Are there any Complementary Studies courses that you have previously taken or are currently enrolled in that you felt were relevant and beneficial to your learning? (Yes/No)	Pre	0.035	1.14	2.79	7.91
	Post	0.014	1.36	3.29	9.27

In both the pre- and post-term results for the question, students in the "Gender Marginalized" category were more likely to identify relevant and beneficial Complementary Studies than those in the "Man" category. The gender difference in this question was somewhat stronger in the post-term survey.

The qualitative analysis codes, irrelevant, and technical/social dualism, were found from the follow up question asking participants who indicated that Complimentary studies courses were not relevant or beneficial to their learning why they felt that way.

The irrelevant code describes responses that described Complementary Studies as unrelated to the rest of their degree, as seen in the quotes below:

> *"I will not need to use these in my career and they irrelevant to my degree."*

> *"they seem way too off topic, very easy courses usually that involve common sense"*

The technical/social dualism code describes responses that emphasized a separation between technical and social courses, sometimes framing Complementary Studies as "too easy" or a waste of time:

> *"My learning experience in the courses was not worth the time or money. It would have been just as good to read a book on the subjects (which I had already so I learned little). I think taking courses in physics or chemistry would have appealed a lot more to me. Courses in the hard sciences and math are much more appropriate for universities."*

> *"Engineering courses are taught to a certain level/difficulty that isn't matched in a lot of the Complementary Studies, they feel like a waste of time in comparison"*

> *"my previous electives were psychologicaly or sociologicaly based so I don't feel they play a key role in the technical aspects of scientific or mathematical design courses." [sic]*

The majority of the respondents that were assigned the irrelevant or technical/social dualism codes identified themselves as men, consistent with the increased odds of men selecting "No" as a response to the associated filter question.

Depoliticization and Social Justice

Regressions on more general questions addressing E4SJ returned three significant results in the pre-term survey and four in the post-term survey, all for gender (Table 4). Men were approximately ten times less likely than Gender Marginalized participants to recognized that engineering projects can neglect the needs of some groups and that social justice is part of an engineer's professional duty. Similarly, Men were typically 3 to 5 times more likely than Gender marginalized participants to self report that all aspects of social justice addressed by these statements are not relevant to (or part of) engineering practice or education. We also note the large discrepancy between pre and post responses to the question on social justice being part of an engineer's professional duty.

Qualitative analysis elucidated codes from five open-ended questions, including three open comment boxes asking students to comment why they did or did not feel the course helped them learn about social justice, privilege and power dynamics, or oppression, respectively. The fourth question was a conditional open-ended question following the question "Should members of equity-deserving groups be consulted before beginning an engineering project?" which asked students who chose "No" why they should not be consulted. Finally, the fifth question arose from a conditional question asking students who agreed with the Likert statement "Engineering projects often prioritize the needs of certain groups and neglect the needs of others" which groups are prioritized or neglected.

Table 4 – Significant depoliticization/social justice regression results for gender. For Likert statements (top 4 statements) odds ratio is the odds of participants who identified as "Gender marginalized" being more likely to agree or have a neutral opinion versus disagree as compared to "Man" participants. For (yes/no) statements (bottom 2 statements) odds ratio is the odds that "Gender marginalized" will select "Yes" as compared to "Man".

Statement (Dependent Variable)	Survey	p value	Gender Marginalized likely to agree/neutral or yes		
			Lower 95%	Odds ratio	Upper 95%
Working towards social justice is part of an engineer's professional duty	Pre	0.000	2.16	4.93	12.81
	Post	0.000	4.47	15.46	97.65
I recognize that I have biases and privileges that may affect my work as an engineer.	Pre	0.017	1.41	3.89	13.76
	Post	0.007	1.81	5.48	23.80
I have a good understanding of what social justice is.	Pre	0.005	1.64	4.18	12.86
	Post	0.006	1.54	3.70	10.36
Engineering projects often prioritize the needs of certain groups and neglect the needs of others.	Post	0.001	1.65	3.26	6.77
Do you feel that learning about social justice in your engineering courses would help you	Pre	0.000	3.63	8.29	21.57
	Post	0.000	2.16	4.66	11.04

better perform your role as an engineer in the future? (Yes/No)					
Should members of equity-deserving groups be consulted before beginning an engineering project? (Yes/No)	Pre	0.015	1.33	3.22	9.09
	Post	0.011	1.54	4.23	14.93

In the post-term survey, students were also asked to self-evaluate a series of competencies (such as empathy, self-awareness, or humility) and any change in them after the course. The fixed mindset code was also applied to an open comment box allowing students to comment on why certain competencies may have weakened or not changed during the course.

Relevant codes from these questions were not new, fixed mindset, no groups, and similar to engineer.

The not new code was determined from responses that discussed how topics or content on social justice, privilege and power dynamics, or oppression in the course were already familiar to the respondent:

"I think some aspects of the lectures touched on social justice, but not to the extent that it was new information for me."

> *"I have already tried to learn about the topic on my own time. The course really only goes as deep into the topic as I did."*
>
> *The fixed mindset code describes responses that expressed the opinion that topics such as social justice, privilege, power dynamics, and oppression, or related competencies cannot be taught (especially in a traditional lecture format), such as in the following quotes:*
>
> *"Empathy and openness cannot be taught in a classroom, you need to learn them actively in the field (labs)."*
>
> *"I'm gonna be real honest with you. Like it's nice that you guys care enough to build a curriculum based on this. But no one in the history of ever has changed themselves because they sat down and listened to a lecture. You can't teach the core elements of being a growing, changing, living breathing human being using a slideshow."*
>
> *"Privilege and power dynamics can never be explained by words. Living, Eating, Sensing, Hearing are some attributes that can only be understood by the person who has experienced it."*

The no groups code was determined from responses that took issue with the term "equity-deserving groups" or asserted it would be a form of inequality to consult equity-deserving groups specifically:

> *"This should not concern an engineer as the goal of engineering is to help people regardless of their status."*
>
> *"They can come forward with their concerns if they occur just like any other individual. It doesnt make sense to just talk to the equity-deserving groups if youre not going to approach everyone" [sic]*

"Anyone effected by these projects should be contacted. Regardless of equity" [sic]

Finally, the similar to engineer code indicates student responses that identified groups similar to the engineer(s) working on the project would be prioritized, as in the following:

"Whatever background the engineers come from"

"groups that the engineering team identify with"

Cross-cutting qualitative themes

Several themes were found that cut across multiple pillars of the culture of disengagement:

- Impact of student positionality and lived experience, including pre-existing knowledge and associated recognition of barriers
- Resistance to learning about non-technical or social concerns due to perceptions as irrelevant, trivial, or not appropriate classroom material
- Misconceptions about equity, social justice, and systemic barriers and associated complexity, including lack of knowledge of equity and justice or explicit power evasion (e.g., 'colourblind' ideology)

We have summarized these themes as they associate with the pillars of the Culture of Disengagement and with the qualitative codes in Table 5.

Table 5 – Crosscutting themes as they relate to the pillars of the Culture of Disengagement and qualitative analysis codes

Theme	Meritocracy	Sociotechnical Dualism	Depoliticization/ Social Justice	Codes
Positionality/lived experience/pre-existing knowledge	X			Equity/access, institutional differences, socioeconomic differences
		X		Technical/social dualism
			X	Not new
Resistance to learning about non-technical or social concerns		X		Irrelevant, technical/social dualism
			X	Fixed mindset
Misconceptions about equity, social justice, and systemic barriers	X			Effort and success
		X		Technical/social dualism
			X	No groups, similar to engineer

Discussion

Results show positionality and lived experience may have considerable relationship with students' meritocratic beliefs, technical/social dualism, and social justice views. These relationships are discussed in the following sections.

A number of student responses provided explicit examples on how their own lived experience, or experiences they personally witnessed, informed their perspective and impacted their meritocratic beliefs:

> *"I believe students with lower a socioeconomic status do not have the same opportunities at all. Being born and raised in [Canadian territory], I have seen very intelligent and talented young individuals not succeed in school solely because of their home conditions. Many students I went to high school with go to school hungry, do not have easy access to basic study material (pencils, books...etc). This sets them back to a point where it creates too large of a gap between other children and destroys their motivation to a point they can not return from."*

However, one student used their lived experience to justify the opposite:

> *"One may be able to afford a tutor, but that does not mean their family provides them with that privilege. I come from a private school background and had to work just as hard as anyone else for chemistry grades in high school (as a specific example). Nobody wants to say this because it sounds privileged, but in reality most public high schools curve grades significantly more than private education, yet the general public seems to believe that private education provides a significant advantage."*

The student's experience of having worked hard in their high school chemistry class and feeling that they fairly earned their grades is provided as justification to dismiss the idea that private education provides an advantage for students to achieve higher grades. According to a 2015 report by Statistics Canada, Canadian private school students outscored Canadian public-school students by around 8-9% on academic tests in grade 10, and by age 23 achieved higher levels of education (Frenette & Chan, 2015). Private school students were also much more likely to have parents with higher levels of education and higher incomes (Frenette & Chan, 2015).

This suggests that privileged students may struggle to make the connection between their privilege and the ways it allowed them to succeed, instead defending their success through adopting a meritocratic mindset that they were given the same opportunity (or perhaps even less opportunity) than everyone else. This aligns well with Friedman et. al.'s discussion of how those from privileged backgrounds may diminish the role of their own privilege in their success through the creation of narratives that present them as somehow disadvantaged, making their success "meritocratically legitimate" (Friedman et al., 2021). Individuals with a lower socioeconomic status were found to perceive a bigger discrepancy between how meritocratic systems should be and how meritocratic they actually are than those of a higher socioeconomic status in (Zimmerman & Reyna, 2013).

Furthermore, these qualitative results help to explain the regression results that showed relationships between gender and meritocratic beliefs for the following two Likert questions:

Two students at the same high school with differing socioeconomic status have the same opportunity to achieve good grades.

Only using high school grades to make admissions decisions is fair.

Here, men had a greater agreement with both statements than women and nonbinary people. This suggests that male engineering students may be more likely to perceive existing systems as meritocratic, at both the individual and institutional level. This is consistent with the underdog thesis, or that individuals in equity-deserving groups who may have had experiences contradicting a dominant ideology (such as meritocracy) are more likely to challenge it (Xian & Reynolds, 2017). However, a student quote shows how gender marginalized students may still reproduce meritocratic beliefs:

"If I was the only women in a group of men, would that mean you want to consult maybe working with more girls? Would you go easier on me for marking? I want to play on an equal level, I will succeed with my own determination to show my value." [sic]

This echoes the findings in (Seron et al., 2018) of some female engineering students perceiving feminism as in opposition to their individualism and sense of meritocracy. This student asserts wanting to have a level playing field while simultaneously seeming to hint at the challenges of being the only woman in a group of men, rejecting the idea of additional support in favor of succeeding through sheer determination.

A student's lived experience may also lead to them adopting a meritocratic mindset if they have been exposed to deeply unmeritocratic conditions elsewhere:

> *"I can see why it's be argued that socioeconomic impact plays a factor is ability to attain higher grades, however I'd argue that it's up to the individual at the end of the day what their goal is. Canada is a very equal opportunity country compared to other places I've lived." [sic]*

Canada is presented as relatively meritocratic in contrast to other places the student lived – whether or not this is true, this leads to a dismissal of the very real systemic oppression that exists in Canada in favour of a meritocratic narrative. As this student only completed the post-term survey, their demographics could not be considered to provide context to this quote. However, for students who are first-generation immigrants or international students, adopting meritocratic ideology may be a necessity for social integration. A study of French university students found that, overall, they evaluated a hypothetical international student with strong meritocratic beliefs more positively than one with weak meritocratic beliefs and thought that all newcomers should adopt a similar worldview (Testé et al., 2012).

Students of a different socioeconomic status than their peers may also struggle with social integration:

> *"Personally, I find it very hard to relate to my peers in a socioeconomic status level, which can feel isolating since it largely influences worldview."*

Research has found a lower socioeconomic status in childhood is associated with poorer social integration later in life (Ashida et al., 2022). Engineering education has a heavy focus on groupwork, so this may have consequences on students' broader learning.

Gender had a significant relationship with which students resisted learning about non-technical topics. There are several reasons students may have responded "No" to the question about complimentary studies, such as logistic challenges in taking the courses they would have liked to, or the specific courses on the Complementary Studies lists. However, the significant effects

of gender in regressions, as well as related qualitative results, suggest other underlying factors. These results are consistent with the literature showing female engineering students are more likely to place importance on the social and ethical dimensions of engineering, and value perspectives outside of engineering (Swartz & Leydens, 2019).

Regressions found significant relationships between gender and various questions intended to examine students' social justice views. Women and nonbinary people were more likely than men to recognize the importance of social justice within engineering across various dimensions, more likely to report a good understanding of social justice, and more likely to recognize the potential impacts of their positionality within their engineering practice. This is consistent with literature showing female students are more likely to recognize inequality and the need to take action to address it than male students (Roberts et al., 2019).

Qualitative results showed resistance to learning about equity and social justice, which may be informed by students' positionality. The code fixed mindsets insisted that social justice and anti-oppression "cannot be taught" or are very difficult to learn about. Fixed mindsets involve the belief that it is impossible (or near impossible) to develop certain skills or aptitudes, as opposed to a growth mindset in which they can be developed through effort or practice (Kaya et al., 2023). These students identified the challenges of learning about topics such as oppression without experiencing them directly and the limitations of lecture as a way of learning them:

> *"Living in Canada - one can never truly grasp the essence of oppression. Being oppressed one doesnt realize oppression. It is also difficult to define oppression. Oppression in Canada is different to oppression in [country in the Global South]." [sic]*

These student responses show a mismatch between how they personally learned about oppression or think it can be learned (firsthand experience), and perceptions of how it was being taught (through lecture and in a Canadian context). These perspectives may be informed by fixed mindsets in the context of oppression, a perception that the E4SJ content was solely presented through lecture, and/or ineffective interventions that did not engage these students.

The vast majority of students providing this perspective belonged to an equity-deserving group in terms of their ethnicity. There was no explicit discussion of oppression in the offering of ENGG*3100 this cohort took, but it seems (understandably) that students who themselves were likely to have faced some form of oppression already were more likely to express hesitation about the possibility of being "taught" oppression. It is possible that seeing content addressing oppression or social justice generally may appear performative or disingenuous for equity-deserving groups who may have dealt with microaggressions, discrimination, and systemic barriers throughout their time at the University of Guelph (and beyond). The overall sense among the student body of a lack of Equity, Diversity, Inclusion, and Indigenization (EDII) initiatives (Dar, Q. 2023) may further show a discrepancy between what is being presented in class and the (lack of) action taken by the University of Guelph to address social justice as an institution.

Potential avenues for addressing fixed mindsets in engineering students include providing opportunities for discussion and reflection on growth mindsets and establishing a sense of value for reflections either through having them count for marks or used to provide advice to future students (Campbell et al., 2021). Further, showing that the University of Guelph values EDII

by raising awareness of existing initiatives and introducing new ones is crucial. Providing BIPOC students with BIPOC-specific spaces where they may reflect on their experiences in engineering, as well as avenues to express their concerns, may help them navigate learning in a predominantly white context.

The student quoted above regarding fixed mindsets also had the following to say in their other responses:

> *"... its difficult to change the cultural and traditional norms in one course. The 'western' society can never comprehend the east - so I dont agree with it. I dont change it." [sic]*
>
> *"... 'western' justice is different from 'eastern' justice"*

This suggests that some students from cultural backgrounds with different conceptualizations of justice and different norms may face barriers in engaging with social justice content. While the University of Guelph is located in Canada, the University of Guelph aims to train global engineers. Integrating different approaches and understandings of justice, besides simply "Western" (European, settler) understandings of justice, may be a valuable way to do so. Further, providing students with options and flexibility in which E4SJ content they focus on (perhaps with both local and global contexts), may help students better connect with the material.

Qualitative results also revealed a wide range in student's places in their social justice (un)learning. While some students recognized the role of their own positionality in their work as an engineer, or how engineers may prioritize designing for people similar to themselves, others were not quite at that stage.

Racial colourblindness asserts that current society is already racially "equal," and that to discuss race or racism is itself racist (Mazzocco, 2017). This form of thinking is tied deeply to meritocracy, as both ideologies maintain the illusion of equality and fairness while ignoring systemic oppression. Research has shown a sense of meritocracy among white individuals can predict a denial of racial inequity better than anti-Black discrimination (Knowles & Lowery, 2012). As a result, "the implication is that white people have secured their position as the dominant race in engineering and engineering education in particular through their own merit" instead of through a history of policy intended to benefit them (Pawley et al., 2018).

Students resisting the categorization of equity-deserving groups, assuming the practice itself is discriminatory, operate from the mindset that society is already equitable. In this line of thinking, "showing special treatment" to equity-deserving groups would be the real inequity as opposed to the history of oppression that necessitated it in the first place. Evidence of this type of student thinking appeared in a variety of responses, including some coded as no groups:

> *"People are all the same despite skin colour and socioeconomic status. bringing attention and showing special treatment in an academic situation creates more of a divide between normal and equity deserving groups" [sic]*
>
> *"Why only the equity deserving groups, when ultimately, we are all human? We should make support available for everyone."*

In what seems to be almost the opposite phenomenon, a comment from a student interview seems to address white saviourism, which is "the idea that people of colour, whether in the

Global South or in the West, need 'saving' from a white western person" (Sondarjee & Kanakulya, 2023):

> *"And then I came to university and then, you know, a lot of people are like, oh, yeah, let's try to help people in Africa. Let's try to help people in the Middle East and South Asia. And it's, it's very interesting because it's like you, you don't really want to help the people. It's more of helping them because you think it'll benefit you."*

This quote presents an interesting contrast to the following two quotes from another student interview:

> *"And so … [our design project] technically it ended up coming down to, let's just take a technological device that we have here in our first world country and make it so it could be more affordable and used within a Second World country."*

> *"I forget where we ended up … [designing our project for] somewhere in South Africa maybe"*

White saviourism is deeply harmful because it ignores the autonomy of those it assumes need to be "saved," in order to emotionally validate the privileged (Cole, 2012). Further research is needed on the ways this thinking may intersect with engineering.

Limitations

There were limitations in the analysis conducted in this paper in working within the power of the data. Responses and demographic categories were binned as needed, and there may have been loss of detail as a result. Only certain questions from the survey had enough power to run regressions. Regressions were only run with a single predictor variable at a time, making it impossible to see any interactions between predictor variables. There was no demographic data for 17 students who only did the post-term survey, and one incomplete pre-term response, which were excluded from regressions. Future surveys should collect demographic data in both surveys.

Regressions did not yield any significant results for ethnicity. Many different ethnicities had to be binned together in order to reduce the number of parameters, while there may be a wide spectrum of views across ethnicities.

The way demographic questions were presented (in the pre-term survey, at the start of the semester) may have caused student confusion or apprehension in how the data would be used. Though recruitment announcements and consent forms aimed to explain the intent of the study, it may be ideal to supplement with a broader context of the overall project.

There may have been some unreliable self-reporting of demographics. For example, in one case a student commented "this is racist" in the comment box where they could specify an unlisted ethnicity. The same student in other responses described social justice as the "downfall of society," suggesting some resistance to the aims of the project. For regressions, all students were binned in the same way for demographics to be consistent.

Implications and Conclusions

This paper aimed to provide an initial characterization of how students' positionality and lived experience may shape their social justice views, meritocratic beliefs, and technical/social dualism within the context of engineering. Our analysis found gender plays a large role in shaping student views, although potential effects from lived experience could not be elucidated.

These results suggest gender may affect engineering students' alignment with the culture of disengagement considerably. For engineering program streams that are male-dominated, such as the mechanical, computer, and systems and computing programs, students may benefit from a focus on more foundational aspects of social justice to ensure they recognize its importance and relevance to engineering.

Including different understandings of justice from various cultures and a range of E4SJ content within which students can direct their learning may allow students to better connect with the material. Explicitly discussing mindsets such as racial colourblindness and white saviorism, and the dangers they pose to E4SJ, may allow students to recognize such thinking in themselves.

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References

Ashida, T., Fujiwara, T., & Kondo, K. (2022). Childhood socioeconomic status and social integration in later life: Results of the Japan Gerontological Evaluation Study. SSM - Population Health, 18. https://doi.org/10.1016/j.ssmph.2022.101090

Bielefeldt, A. R., & Canney, N. E. (2016). Changes in the Social Responsibility Attitudes of Engineering Students Over Time. Science and Engineering Ethics, 22(5), 1535–1551. https://doi.org/10.1007/s11948-015-9706-5

Campbell, A. L., Direito, I., & Mokhithi, M. (2021). Developing growth mindsets in engineering students: a systematic literature review of interventions. European Journal of Engineering Education, 46(4), 503–527. https://doi.org/10.1080/03043797.2021.1903835

Cech, E. A. (2014). Culture of Disengagement in Engineering Education? Science Technology and Human Values, 39(1), 42–72. https://doi.org/10.1177/0162243913504305

Cech, E. A., & Blair-Loy, M. (2010). Perceiving glass ceilings? Meritocratic versus structural explanations of gender inequality among women in science and technology. Social Problems, 57(3), 371–397. https://doi.org/10.1525/sp.2010.57.3.371

Claussen, S., Howland, S. J., Nittala, S., Jesiek, B., & Zoltowski, C. (2021, July 26). Longitudinal Qualitative Case Study of One Engineering Student's Perceptions of Ethics and Social Responsibility: Corvin's Story. ASEE Annual Conference.

Cole, T. (2012, March 21). The White-Savior Industrial Complex. The Atlantic.

Dar, Q. (2023) Examining the Pillars of the Culture of Disengagement in Engineering Education [Master's thesis, University of Guelph].

Dirks, S. (2023, July 2). Affirmative action divided Asian Americans and other people of color. Here's how. NPR.

Faulkner, W. (2007). "Nuts and bolts and people": Gender-troubled engineering identities. Social Studies of Science, 37(3), 331–356. https://doi.org/10.1177/0306312706072175

Fernández, D. P., Ryan, M. K., & Begeny, C. T. (2022). Support (and rejection) of meritocracy as a self-enhancement identity strategy: A qualitative study of university students' perceptions about meritocracy in higher education. European Journal of Social Psychology. https://doi.org/10.1002/ejsp.2925

Finkelstein, M. A. (2011). Correlates of individualism and collectivism: Predicting volunteer activity. Social Behavior and Personality, 39(5), 597–606. https://doi.org/10.2224/sbp.2011.39.5.597

Frenette, M., & Chan, P. C. W. (2015). Why Are Academic Prospects Brighter for Private High School Students? https://www150.statcan.gc.ca/n1/pub/11-626-x/11-626-x2015044-eng.pdf

Friedman, S., O'Brien, D., & McDonald, I. (2021). Deflecting Privilege: Class Identity and the Intergenerational Self. Sociology, 55(4), 716–733. https://doi.org/10.1177/0038038520982225

Garrison, Y. L., Rice, A., & Liu, W. M. (2021). The American Meritocracy Myth Stress: Scale Development and Initial Validation. Counseling Psychologist, 49(1), 80–105. https://doi.org/10.1177/0011000020962072

Hagiwara, N., Alderson, C. J., & McCauley, J. M. (2015). "We get what we deserve": the belief in a just world and its health consequences for Blacks. Journal of Behavioral Medicine, 38(6), 912–921. https://doi.org/10.1007/s10865-015-9652-3

Hsiung, P.-C. (2010, August). Lives & Legacies: A Guide to Qualitative Interviewing. University of Toronto Scarborough. https://www.utsc.utoronto.ca/~pchsiung/LAL/

Hu, S., Shen, X., Creed, P. A., & Hood, M. (2020). The relationship between meritocratic beliefs and career outcomes: The moderating role of socioeconomic status. Journal of Vocational Behavior, 116. https://doi.org/10.1016/j.jvb.2019.103370

Javadizadeh, B., Ross, J., Valenzuela, M. A., Adler, T. R., & Wu, B. (2022). What's the point in even trying? Women's perception of glass ceiling drains hope. Journal of Social Psychology. https://doi.org/10.1080/00224545.2022.2119121

Kaya, S., Yuksel, D., & Curle, S. (2023). The effects of language learning and math mindsets on academic success in an engineering program. Journal of Engineering Education, 112(1), 90–107. https://doi.org/10.1002/jee.20499

Knowles, E. D., & Lowery, B. S. (2012). Meritocracy, Self-Concerns, and Whites' Denial of Racial Inequity. Self and Identity, 11(2), 202–222. https://doi.org/10.1080/15298868.2010.542015

Kozan, S., Gutowski, E., & Blustein, D. L. (2019). A Qualitative Exploration of Women's Work Aspirations and Beliefs on Meritocracy. Journal of Counseling Psychology. https://doi.org/10.1037/cou0000409

Landis, J. R., & Koch, G. G. (1977). The Measurement of Observer Agreement for Categorical Data. Biometrics, 33(1), 159–174.

Lucena, J., & Leydens, J. (2018). Engineering Justice: Transforming Engineering Education and Practice. John Wiley & Sons.

Mazzocco, P. J. (2017). The Psychology of Racial Colorblindness. Palgrave Macmillan US. https://doi.org/10.1057/978-1-137-59302-3

McCann, S. J. H. (2022). Does diversity foster individualism? The relation of racial-ethnic diversity to individualism-collectivism across the 50 American States. Journal of Social Psychology. https://doi.org/10.1080/00224545.2022.2085073

McGee, E. (2018). "Black Genius, Asian Fail": The Detriment of Stereotype Lift and Stereotype Threat in High-Achieving Asian and Black STEM Students. AERA Open, 4(4). https://doi.org/10.1177/2332858418816658

Nili, A., Tate, M., & Barros, A. (2017). A Critical Analysis of Inter-Coder Reliability Methods in Information Systems Research. Australasian Conference on Information Systems, 1, 1–11.

O'Connor, C., & Joffe, H. (2020). Intercoder Reliability in Qualitative Research: Debates and Practical Guidelines. International Journal of Qualitative Methods, 19. https://doi.org/10.1177/1609406919899220

Panetta, A. (2023, June 29). U.S. court strikes severe blow to affirmative action. Here's what's next. CBC.

Pawley, A. L., Mejia, J., & Revelo, R. (2018, June 24). Translating Theory on Color-blind Racism to an Engineering Education Context: Illustrations from the Field of Engineering Education. ASEE Annual Conference.

Peduzzi, P., Concato, J., Kemper, E., Holford, T. R., & Feinstein, A. R. (1996). A Simulation Study of the Number of Events per Variable in Logistic Regression Analysis. J Clin Epidemiol, 49(12), 1373–1379.

Perez, A. D., Dufault, S. M., Spears, E. C., Chae, D. H., Woods-Giscombe, C. L., & Allen, A. M. (2023). Superwoman Schema and John Henryism among African American women: An intersectional perspective on coping with racism. Social Science and Medicine, 316. https://doi.org/10.1016/j.socscimed.2022.115070

Professional Engineers Act, R.R.O 1990, Regulation 941, section 77. Available at: https://www.ontario.ca/laws/statute/90p28.

Roberts, M. R., Turner, W., Howard, L. A., Gilles, E. E., & Statham, A. (2019). Gender and Social Justice: An Examination of Attitudes and Behaviors Among Undergraduate Liberal Arts Students. Affilia - Journal of Women and Social Work, 34(4), 552–567. https://doi.org/10.1177/0886109919866151

Robinson, M. N., & Thomas Tobin, C. S. (2021). Is John Henryism a Health Risk or Resource?: Exploring the Role of Culturally Relevant Coping for Physical and Mental Health among Black Americans. Journal of Health and Social Behavior, 62(2), 136–151. https://doi.org/10.1177/00221465211009142

Rodrigues, R. B., & Seniuk Cicek, J. (2024). A scoping literature review of sociotechnical thinking in engineering education. European Journal of Engineering Education, 49(5), 807–833, https://doi.org/10.1080/03043797.2024.2346344.

Rulifson, G., & Bielefeldt, A. R. (2019). Evolution of Students' Varied Conceptualizations About Socially Responsible Engineering: A Four Year Longitudinal Study. Science and Engineering Ethics, 25(3), 939–974. https://doi.org/10.1007/s11948-018-0042-4

Sampat, N. (2022, May 10). Dispelling Myths: Model Minority and Meritocracy as Sources of Harm and Hierarchy.

Schiff, D. S., Logevall, E., Borenstein, J., Newstetter, W., Potts, C., & Zegura, E. (2021). Linking personal and professional social responsibility development to microethics and macroethics: Observations from early undergraduate education. Journal of Engineering Education, 110(1), 70–91. https://doi.org/10.1002/jee.20371

Schoonenboom, J., & Johnson, R. B. (2017). How to Construct a Mixed Methods Research Design. Kolner Zeitschrift Fur Soziologie Und Sozialpsychologie, 69(2), 107–131. https://doi.org/10.1007/s11577-017-0454-1

Seron, C., Silbey, S., Cech, E., & Rubineau, B. (2018). "I am Not a Feminist, but..": Hegemony of a Meritocratic Ideology and the Limits of Critique Among Women in Engineering. Work and Occupations, 45(2), 131–167. https://doi.org/10.1177/0730888418759774

Sondarjee, M., & Kanakulya, D. (2023, February 26). How white saviourism harms international development. The Conversation.

Swartz, M., & Leydens, J. A. (2019). Is Sociotechnical Thinking Important in Engineering Education?: Survey Perceptions of Male and Female Undergraduates. ASEE Annual Conference.

Testé, B., Maisonneuve, C., Assilaméhou, Y., & Perrin, S. (2012). What is an "appropriate" migrant? Impact of the adoption of meritocratic worldviews by potential newcomers on their perceived ability to integrate into a Western society. European Journal of Social Psychology, 42(2), 263–268. https://doi.org/10.1002/ejsp.1844

Trytten, D. A., Lowe, A. W., & Walden, S. E. (2012). "Asians are good at math. What an awful stereotype": The Model Minority Stereotype's impact on Asian American engineering students. Journal of Engineering Education, 101(3), 439–468. https://doi.org/10.1002/j.2168-9830.2012.tb00057.x

Turpen, C., Radoff, J., Gupta, A., Sabo, H., & Elby, A. (2019). Examining How Engineering Educators Produce, Reproduce, or Challenge Meritocracy and Technocracy in Pedagogical Reasoning. ASEE Annual Conference & Exposition. https://doi.org/10.18260/1-2--32778

UN Sustainable Development Goals, https://www.un.org/sustainabledevelopment/sustainable-development-goals/, accessed May 2026

Xian, H., & Reynolds, J. (2017). Bootstraps, Buddies, and Bribes: Perceived Meritocracy in the United States and China. Sociological Quarterly, 58(4), 622–647. https://doi.org/10.1080/00380253.2017.1331719

Zimmerman, J. L., & Reyna, C. (2013). The Meaning and Role of Ideology in System Justification and Resistance for High- and Low-Status People. Journal of Personality and Social Psychology, 105(1), 1–23. https://doi.org/10.1037/a0032967