Racialized Trauma for Black, Latin, and Indigenous Engineering Students: A Systematic Literature Review.

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Abstract

Structures of racism, colonization, and white supremacy have traditionally excluded minoritized populations, namely Black, Latin, and Indigenous (BLI) communities, from participation and success in engineering. For example, the inequity in the P-12 experience, resources, and training is well documented. As a result, underserved BLI students experience disadvantage upon entering engineering spaces compared to their white counterparts. This setback and subsequent expectation to perform at a level that requires previous knowledge not yet obtained create environments of undue stress for BLI students in addition to the stressors of engineering education inherent in the curriculum. The repression and neglect of marginalized identities within engineering learning environments undermine their learning process and echo the traumatic historically raced or racialized experiences of those holding those identities. The objective erasure of identities or the false notion of meritocracy based on colorblindness in traditional engineering education contributes to the stress, distress, and trauma (SDT) of BLI students.

The purpose of this literature review is to gather literature surrounding SDT within the experiences of undergraduate engineering BLI students. This serves the greater purpose of the study: to make clear that traditional engineering education can serve as a stressor that is sufficient to (1) cause/initiate distress and dysfunction or (2) maintain/make worse pre-existing stress reactions. To navigate the literature in this review, we use the guiding research question: **How has engineering education research explored the racialized experiences of stress, distress, and trauma of Black, Latin, and Indigenous students in the context of engineering education?**

To answer our research question, we chose to perform a systematic literature review. After rounds of exclusion, we analyzed a set of 18 articles using two rounds of categorical analysis. Findings from the categorical analyses reveal that several gaps surrounding racialized SDT for BLI students exist in engineering education research (EER). For example, little research is done regarding Indigenous students' experiences of SDT, and little more is done on Latin students' experiences of SDT. Though Black students' experiences composed most of the papers in this literature review, their stories are still underrepresented within the whole of EER.

Overall, this literature review identifies the gaps in the literature for the SDT experiences of BLI students in engineering. As BLI students are forced into a process of acculturation into the engineering environment and culture, which is predominantly white and masculine space, the mismatch of personal and engineering identities can lead to mental distress. Further research is needed to understand the nuanced, intersectional experiences of BLI students in engineering to uproot and disrupt the practices that create or lead to inequitable outcomes in engineering student experiences.

Key Words: Trauma; Stress; Distress; BLI Students; Engineering

Introduction

Students undergo various experiences during their college years that influence and shape their identities. Negative interactions within those experiences can affect the mental functioning and wellbeing of the students. These negative experiences result in high levels of distress that may not be clearly visible to peers or faculty but can have significant impacts within their collegiate choices. Available research indicates that approximately 50% of students display alarming levels of stress, anxiety, and depression [1], [2]. This statistic is an indicator of a mental health crisis that could be ravaging higher education institutions. Recent engineering education research (EER) has also called attention to the issue specifically within the context of engineering education [3] and undergraduate engineering stress culture [4].

In this paper, we define stress as the circumstances or the relationship between the individual and the environment appraised in terms of relevance to well-being and in which personal resources are taxed or exceeded [5].Similarly, we define distress as the experience of a set of negative responses—for instance, anxiety, depression—that are the consequence of confronting severe or prolonged stress and result in an inability to perform actions that are generally considered appropriate to a given functional domain, in this case work or school [6]. Trauma, a situation or occurrence that can lead to significant distress or lead to a traumatic response in an individual, is one of the negative reactions to stress that can have detrimental repercussions on students' lives [7]–[11].

Drawing from these definitions and the historical exclusion or limited participation of minoritized identities, in the paper we focus on the experiences of underserved students within the underrepresented groups, specifically Black, Latine/o, and Indigenous (BLI). The combination of these facts demands framing of stress in the context of race. Previous research documents engineering students have self-reported elevated levels of SDT during their engineering education [12]. BLI engineering students not only face the high levels of engineering stress from the culture [13]–[15], but they can also experience racialized interaction within their engineering education [16], [17]. This additional contribution of SDT based on racialized experiences amounts to racialized SDT. Also referred to as race-based traumatic stress, racialized stress is a type of stress due to the emotional and psychological stress responses resulting from experiences of racial discrimination [18]. Table 1 shows a summary of our operationalized definitions of these terms.

Table 1: Operationalized Definitions for SDT

Concept	Operationalized Definition
Stress	The psychological perception of pressure and the body's response to it.
Racialized Stress	Also referred to as race-based traumatic stress, a type of stress that has been defined as a psychological stress response resulting from experiences of racial discrimination.
Distress	The negative stress response often involving negative affect and physiological reactivity. Distress results from being overwhelmed by demands, losses, or perceived threats and can lead to maladaptive practices.

Concept	Operationalized Definition
Trauma	An event or circumstance that can cause significant intrapersonal and interpersonal distress as well as disruptions in function across multiple domains.

Racialized SDT has not been connected to the experiences of BLI students in EER. This literature review seeks to clarify this gap in the literature and summarize what is known about racialized SDT in engineering. Our mission echoes the call by Jensen [4] for creating a culture of well-being that systematically addresses the racial prejudice and discrimination long ignored in engineering and the impacts borne by traditionally excluded students. Also, the racialized SDT is similar to the construct of racial microaggressions [19]–[21], but that is beyond the scope of the current review of the literature.

The purpose of this literature review is to gather literature surrounding SDT within the experiences of undergraduate engineering BLI students. This serves the greater purpose of the study: to make clear that traditional engineering education can serve as a stressor that is sufficient to (1) cause/initiate distress and dysfunction or (2) maintain/make worse pre-existing stress reactions. To navigate the literature in this review, we use the guiding research question: **How has engineering education research explored the racialized experiences of stress, distress, and trauma of Black, Latin, and Indigenous students in the context of engineering education?**

Background

Engineering has long been perceived as white-male dominated [22], [23], with BLI students widely underrepresented and alienated [24]–[26]. Consequently, scholarship on inclusion and broadening participation has delved on the interaction between students and the engineering campus environment through the lenses of sense of belonging, school support structures and faculty mentorship [26]–[31].

The campus climate and culture of engineering schools presents itself, for instance, through experiences of bias and microaggressions thus contributing to the SDT of BLI students [21], [32], [33]. If this trend is maintained, these high stress levels will continue to erode the sense of belonging and engineering identity, factors of which are key predictors of performance and persistence [1]. Despite the connections to important engineering outcomes, the work examining mental health in engineering has largely ignored the racialized components of stress and distress that can have negative impacts on their physical and psychological well-being and hence exit from engineering. Premised on this, it is critical to understand how racial stereotypes, biases, and microaggressions impact BLI engineering student outcomes, with emphasis on stress, distress, and trauma.

Methods

Researcher Positionality

To provide context to this work and the aspects of our experiences that shape the ways we approach research, we have provided positionality statements [34] for each member of the research team.

Elahe Vahidi: I am a middle-eastern, heterosexual, woman, raised in a large city in Iran, with multidisciplinary academic background in engineering and educational psychology. I graduated with a bachelor's degree in electrical engineering from a public university in Iran. My interest in psychological foundations of education led me to pursue graduate degrees in educational psychology. Aligning with my educational experiences, my research interests are situated at the intersection of engineering, psychology, and education. I identify as a mother-scholar whose studies are intentionally in a dynamic interaction with the lived experiences of mothering. The goal of my research is to understand mental experiences, relationships, and mental wellbeing of underrepresented students and faculty. I also explore how these experiences and relationships are associated with representation, retention, and advancement of students and faculty in engineering. My research pursuits allow me to contribute to my larger research strand which is to transform the culture/climate in engineering education by addressing the social and emotional needs of students and faculty.

Mark Onyango: I am a heterosexual African male, first-generation engineering and PhD student in my family. I graduated with a Bachelor of Education (Electrical Technology) and a master's degree in information and communication engineering. With work experience spanning engineering industry and technical and vocational education and training teaching, my research centers on underrepresented groups with a focus on efforts to advance solutions on broadening participation in engineering spaces, both in college and the workplace.

Kaitlyn Thomas: I am a heterosexual, white woman raised by two working-class parents in a double-income household. Both parents are first-generation college graduates from the Midwest, and they raised me and my two siblings in Orange County, California. I graduated from a private, teaching-focused university in Texas with bachelor's and master's degrees in civil engineering with an emphasis on structural engineering. I also worked for three years as a structural engineer before going back to school and pursuing engineering education. My education and career in engineering took place in predominantly white, male settings. Because of the privilege I experience as a white person and the sheltering of experiences that my privilege offers, I have undergone a massive amount of learning to identify systems of oppression embedded in the culture that may limit others in the profession. My goal with my research is to explore norms in engineering to understand and identify systems of oppression embedded in the culture that may limit marginalized communities in the profession.

Whitney Gaskins: I am a Black, cisgender heterosexual female who identifies as a Christian who is an empowerment enthusiast for marginalized populations. I started my career as an engineer in industry working for foreign-based automobile manufacturer. I transitioned to academia and currently work as an engineering associate professor and associate dean for inclusive excellence and community engagement. I also oversee a K-12 community foundation that encourages underrepresented minority students to pursue careers in STEM. I was raised in a predominantly white, rural Midwestern area by parents who both hold college degrees. My passion for my work comes from my desire to create opportunities for marginalized individuals who have traditionally been underserved in our society. My work generally focuses on increasing access to spaces and ensuring that individuals have positive experiences within those spaces.

Kelly Cross: I am a Black, female, same-sex loving engineering professor with strong beliefs around spirituality. I am a first-generation PhD in my family and was raised in a racially and economically segregated large city in the Midwest. My research agenda is to broaden participation in engineering. My previous research investigated the experiences of multiple

marginalized groups including women of color and members of the LGBTQ spectrum. I typically take an intersectional approach to identity in research and I am passionate about giving voice to those often overlooked in the business of educating engineers in the U.S.

Methodology

We employed the systematic literature review methodology outlined in Borrego et al. [35] for this paper. First, we accumulated articles in an initial database search of four (4) journals relevant to EER from 2000 to 2023. We performed secondary and tertiary rounds of exclusion on the accumulated articles by reading through them and determining if they addressed our research question. After excluding all articles that were out of the scope of this literature review, we performed two categorical analyses on the remaining articles.

Data Collection

The data collected in the systematic literature search were from papers from the following four (4) journal databases from 2000-2023.

- Journal of Engineering Education (JEE)
- Journal of Higher Education (JHE)
- Journal of Research in Science Teaching (JRST)
- American Education Research Journal (AERJ)

These publication sources were selected due to being highly cited within the field of engineering education. We used the following search criteria to accumulate the preliminary set:

"Black student + stress OR Latin* student + stress OR Indigenous student + stress",
"Black student + distress OR Latin* student + distress OR Indigenous student + distress",
"Black student + trauma OR Latin* student + trauma OR Indigenous student + trauma."

To appropriately scope the literature review, we used multiple exclusion criteria. First, any literature focusing on faculty, graduate students, or postdoctoral students was omitted. Second, literature published before the year 2000 was excluded as much has changed in the field of trauma studies since the 1990's. Lastly, any guest editorials or conference proceedings that did not include a paper were excluded from the literature review.

After an initial search through the journal databases, we screened the papers based on reading through titles and abstracts for key words and phrases. Then, we analyzed the remaining articles with secondary and tertiary rounds of exclusion based on how well the papers answered our research question. The secondary round of exclusion involved reading through the methods section to explore if the undergraduate BLI students are (part of) the target population. After excluding articles based on this criterion, 41 articles remained in the literature review. Lastly, a final round of exclusion was performed involving a full read of the paper to narrow down the articles. If the paper did not focus on the experiences of BLI students or SDT-related instances, it was excluded. Table 2 shows the process of exclusion for the papers from each journal in this literature review. The initial 660 articles were narrowed down to 18 articles that satisfied the inclusion and exclusion criteria.

Table 2: Paper counts at each iteration of the literature search process

Journal	Paper count after initial keyword search	Paper count after title and abstract review	Paper count after methods review	Paper count after full read
Journal of Engineering Education (JEE)	137	41	18	7
Journal of Higher Education (JHE)	70	19	13	3
Journal of Research in Science Teaching (JRST)	183	6	3	1
American Education Research Journal (AERJ)	270	34	7	7
Total	660	100	41	**18**

Data Analysis

Once we determined the final set of articles, we analyzed the data through a "synthesis" [35, p. 60] process involving mapping papers into categories, which were recorded in a table. We performed categorical analyses to compare each article across multiple groupings of attributes. The first categorical analysis involved sorting each paper into two categories: papers in which SDT experiences of BLI students is the focus and papers in which SDT experiences of BLI students are not the main focus but part of findings and/or are discussed to explain the findings of the paper. The second category was further categorized into two groups: papers that talk about SDT as part of culture/climate in engineering education and papers that talk about SDT as a factor associated with specific constructs. We chose to categorize papers in this way because we determined after reading the articles that scarce articles focused on SDT experiences of BLI students as the main topic of the paper. Figure 1 shows how the papers were categorized.

The second categorical analysis involved the extraction of several attributes of each paper including theoretical framework, methodology, target population, and measurement instruments. These attributes were described in a table that laid out each article and its contents. This table allowed us to examine possible trends between papers. Together, these categorical analyses helped us to draw conclusions about how racialized trauma for BLI students have and have not been discussed in EER.

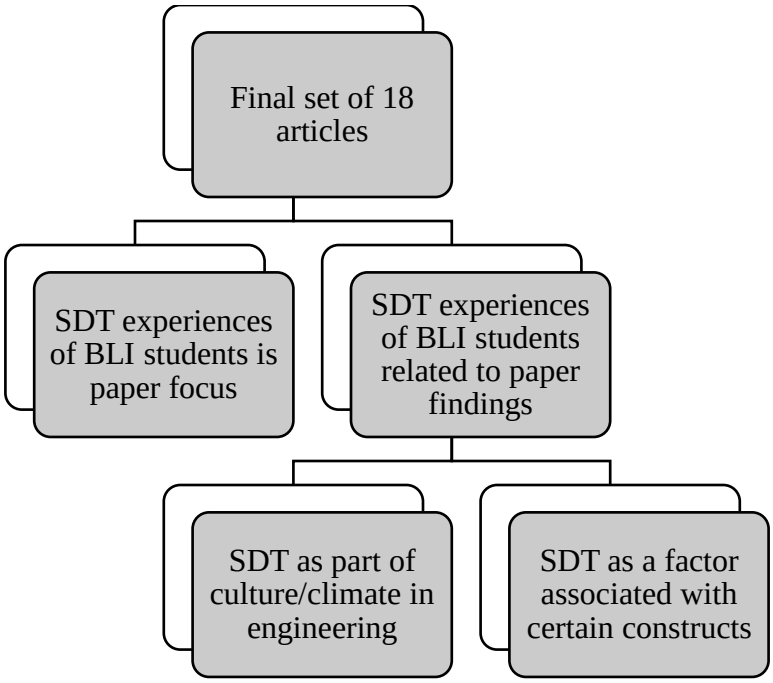

Figure 1: Categorical breakdown of articles for first categorical analysis

Limitations

The scope of this literature review was limited by time, accessibility, and availability of the research team. This literature review is part of a larger study, and the literature review is one of the first steps in the project. As this had to be completed before next steps could be taken, the time for the literature search and analyses was limited. The team was also limited by access to journal databases. We gathered articles from the EER journals that were accessible through our institutions, but some were left out because of lack of accessibility combined with time and research team constraints. Lastly, this review was limited by the capacity of the research team to synthesize 660 articles within the time constraints of the literature review. Future work may include expanding the literature review to include the EER journals that were inaccessible to the research team for this paper.

Quality

The research team maintained quality throughout the literature review process. First, we kept careful documentation of the literature review methods so it may be replicated or reviewed by future team members or outside researchers. This included meeting minutes and recordings with the team, shared documents for detailing findings, and spreadsheets showing each step of the data analysis process (exclusion steps and each categorical analysis). Next, the research team met at weekly intervals to update everyone on progress made and make plans to accomplish our research goals on time. Throughout these meetings, we iteratively reviewed the process by Borrego et al. [35] to stay aligned with the methodology of the literature review. Lastly, we delegated tasks such that at least one other researcher could review others' work. Through the processes of recording, documentation, and multiple reviews, the research team ensured the literature review was robust and aligned with the overall purpose of the larger study.

Results

The analysis of the literature based on the first categorical analysis yielded two key findings. First, among the 18 papers in the literature review, only one of them looked at racialized SDT directly and as its main aim [21] (see Figure 2). In this longitudinal quantitative study, Keels, Durkee, and Hope show that racial and ethnic microaggressions in the educational context are detrimental to students' academic achievement and mental health [21]. Though this paper was the only one that aimed to explore SDT for minoritized students, the authors did not use insights from trauma-informed theories to discuss their findings. In addition, the participants of this study were Black and Latinx students across different majors including engineering. Hence, Indigenous students were not included and engineering educational context was not considered to understand findings. In summary, only one paper in this literature review focused on racialized SDT for minoritized students. However, this study did not use trauma-informed theory in its frameworks, and it does not include Indigenous students or the engineering context in its findings. This shows a tremendous gap in literature for studying racialized SDT for BLI engineering students.

Second, in the other 17 studies, the authors used SDT as part of their findings or to discuss their findings, but they still did not aim to explore and understand racialized experiences of SDT for BLI students, specifically. Among them, eight studies focused on the climate and culture of engineering learning environments and how BLI students experience them (See Figure 2). In these studies, racialized SDT was found and/or discussed as part of climate/culture experiences for BLI students. For instance, McGee [11] explains that the findings of the study demonstrate "the value of stereotype management for affirming academic competency, but the tactic does not keep students from enduring racialized stress and anxiety." [11, p. 1653]. Of the eight papers that focused on engineering climate and culture, only two used trauma-informed theories to frame their studies and discuss their findings. The other nine studies aimed to explore specific constructs (e.g., college involvement, and belongingness) and mentioned SDT as an adjacent factor (See Figure 2). For example, Patrick and colleagues [26] situated the findings in a theoretical framework in which stress engagement is one of the components and explained the stress could come from several sources such as experiencing racial discrimination.

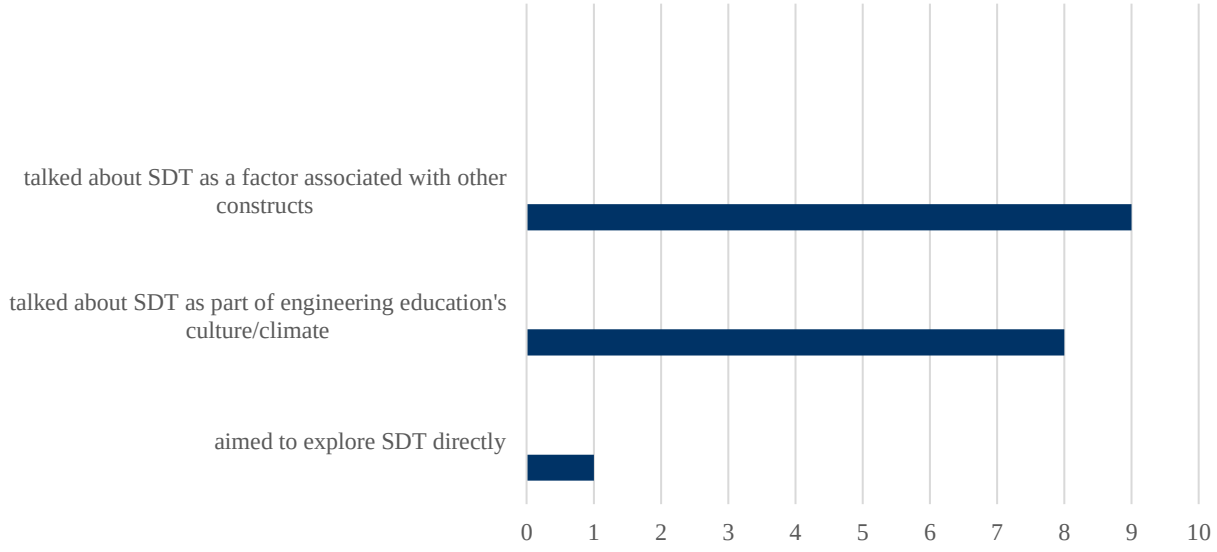

Figure 2: Paper counts with regard to mentions of SDT

Based on the first categorical analysis, while none of the papers in this literature aim to understand racialized SDT experiences of BLI engineering students as the focus of the research, SDT is a common theme when exploring how BLI students experience engineering culture and climate and a common factor discussed in association with other constructs, such as BLI students' sense of belonging. Together, these findings reveal a potential gap in the literature regarding focusing on racialized trauma in engineering education.

The analysis of the literature based on the second categorical analysis revealed that, compared to Black students, little research is done regarding Indigenous students' experiences of SDT, and little more is done on Latin students' experiences of SDT. We hypothesize that the low number of papers collected surrounding Indigenous students' experiences stems from the low number of Indigenous students in engineering. Low results for Latin students may stem from issues in the search term "Latin*", which may not capture the multiple labels for Latin students, including "Hispanic,", "Mexican American," etc. We chose to use the term "Latin*" because it encapsulated Hispanic and Mexican American students in its definition, but if authors did not use the term in their articles, the papers would not be captured in the search. Though unfortunate, this was the decision made in our methods. Of all 18 articles, Black students were the most represented in the research on or surrounding SDT. Though Black students' experiences composed most of the papers in this literature review, their stories are still underrepresented and undervalued within the whole of EER.

The last finding that resulted from this literature review is the variety of methodology types in the papers in this literature review (See Figure 3). Of the nine qualitative studies, researchers used methodologies such as interpretative analysis [36], case study [37], and ethnography [38]. Out of the other 9 papers, five papers used quantitative findings [21], [26], [28], [39], [40] and four papers utilized mixed methods [41]–[44]. These numbers show that all three methodologies are relatively represented in literature. Though this literature review revealed large gaps in EER regarding racialized SDT for BLI students, the variety of methodologies used to study this topic, whether directly or tangentially, show that the research community is interested in the topic enough to approach it in multiple ways. The findings in this literature review emphasize not only the importance of but the interest in studying racialized SDT for BLI students.

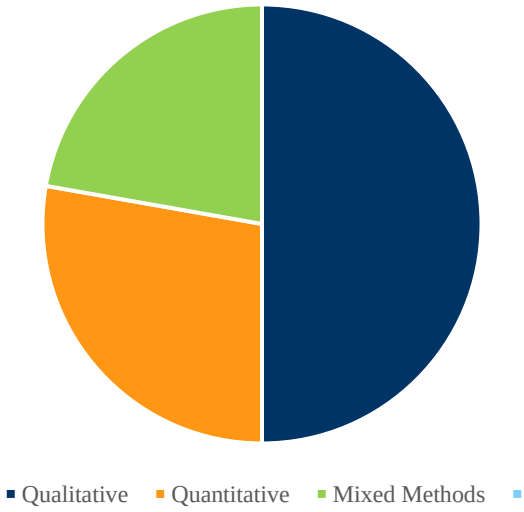

Figure 3: Paper counts according to methodology type

Discussion and Future Directions

With this literature review, we sought to investigate how engineering education research has explored the experiences of BLI students regarding racialized stress, distress, and trauma in the context of their engineering education. To address our research question (How has engineering education research explored the racialized experiences of stress, distress, and trauma of Black, Latin, and Indigenous students in the context of engineering education?), we performed a systematic literature review including a multi-round exclusion to find papers that fitted our inclusion and exclusion criteria. Categorical analysis of the articles showed that none of the papers in this review investigated racialized SDT experiences of BLI students in the context of engineering education, specifically.

Although BLI students' racialized SDT experiences were not centered in any of the studies, this literature review revealed that SDT is repeatedly found or discussed in studies that explore BLI students' experiences of culture/climate in engineering education. It is also commonly found or discussed in association with other educational experiences such as retention and adjustment. Together, these findings reveal how culture/climate and the default educational practices in engineering may intensify SDT experiences that disproportionately influence BLI students. We intentionally made the distinction between studies centered around racialized SDT experiences of BLI students and those studies that discussed SDT as a factor associated with the central construct of studies and/or as part of engineering culture/climate. In this way, we can highlight that though EER talks about SDT, a gap exists in the literature regarding racialized trauma in engineering.

This paper revealed that Indigenous students' experiences of SDT have scarcely been studied, and little more is done on Latin students' experiences of SDT. Besides, BLI students were aggregated together or with other underrepresented communities in most studies. One reason behind this trend is the low number of BLI students, specifically Indigenous students, in engineering [45]. This is particularly important in quantitative research, in which small numbers of students tend to get grouped together with other demographics to create a statistically significant sample. It can help highlight structural and systematic barriers that marginalize BLI students. However, aggregating may overlook the unique experiences and challenges faced by specific racial groups and it may obscure the nuanced understanding of the experiences of discrimination and oppression within each community [36], [46]. While we understand the pros and cons of grouping racial communities together in research, we are not disaggregating BLI for 3 reasons: 1) small numbers of the group exist in STEM disciplines particularly around this understudied topic, 2) given the small numbers we do not want to risk identifying our participants, and 3) SDT is understudied in engineering, and we want the data to identify demarcations rather than arbitrary designations of race that are socially constructed.

Future works should focus on racialized trauma experiences of BLI engineering students directly to advance knowledge and highlight how culture/climate and the default educational practices in engineering may intensify SDT experiences that disproportionately influence BLI students. Specifically, future studies are needed to yield an integrative model of racialized trauma related to the engineering educational context. This model will expand current theories and practices for understanding racialized trauma and will serve as a basis to better understand experiences of BLI students, develop measures of stress and trauma in engineering, and develop and update engineering education pedagogy to be less traumatizing and more healing.

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