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A Descriptive Study on Biased and Non-Inclusive Language Use in the Engineering Education Research Community

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Abstract

Promoting diversity, equity, and inclusion (DEI) offers multiple benefits to the academic world. There are many approaches to advancing DEI, one of which is through mindful use of language. Thoughtful language can help foster inclusivity, contributing to the broader goal of creating an inclusive and equitable academic environment. In particular, the American Psychological Association (APA) has published a language use guideline that provides instruction on language usage that offers practical suggestions and highlights examples of biased language commonly found in academic writing. In this academic atmosphere, the engineering education community is increasingly recognizing that language use is one of the essential components of creating an inclusive and equitable learning environment. While the influence of language on educational experiences has been the subject of several scholarly papers, no research have looked explicitly at language use patterns in the field of engineering education or the possible negative effects of biased language.

In light of this, the present study integrates two conceptual frameworks: implicit bias theory and academic literacy theory. This approach allows for a detailed investigation into biased language use trends within engineering education research, as well as an understanding of how these trends diverge from the field's goals of diversity and inclusion. Implicit bias theory examines unconscious attitudes and stereotypes that subtly but significantly influence language use in academic settings. Meanwhile, academic literacy theory sheds light on the conventions and practices of communication in academic writing.

To determine what constitutes biased language, we developed a keyword-based model in accordance with the latest APA 7th language guidelines. We identified 85 keywords from the guide and grouped them into seven categories. The study analyzed 5,237 conference proceedings published at the American Society for Engineering Education Annual Meetings from 2020 to 2022. By employing the keyword-based model in R, we applied the keyword-based model to detect instances of biased language within the proceedings. Our analysis revealed a slight decrease in biased language usage over time, with 359 unique instances detected in 2020, compared to 283 instances in 2022. The three most persistent categories of biased language over the three years were Gender, Racial and Ethnic Identity, and Socioeconomic Status. Specifically, the top five most frequently used biased terms were "Females/Males," "Caucasian," "Achievement Gap," "The Poor," and "The Elderly."

Introduction

The engineering society in the United States has historically encountered substantial obstacles, most notably the inadequate representation of specific demographics, including women and racially minoritized students and scholars (Alfred et al., 2019; Bottia et al., 2015, 2021; Cheryan et al., 2017; Meyer et al., 2015). This issue extends beyond social justice and equity concerns; it has profound implications that can potentially influence the development of the engineering workforce and the quality of engineering education and research. Diverse perspectives are essential for fostering innovative environments and addressing complex societal problems through engineering education solutions (Freeman et al., 2014; Johnson, 2019; Madden et al., 2013). Previous research has shown that individuals from diverse backgrounds bring unique viewpoints that collectively enhance creativity and problem-solving capabilities (Lee &

Park, 2020; Madden et al., 2013; Peifer, 2019). In educational settings, a diverse student population contributes to comprehensive thinking, enhances personal and social learning, and fosters critical thinking skills (Andrade, 2020; Juvonen et al., 2019; Roksa et al., 2017). In addition, including diverse voices and perspectives can lead to more comprehensive and thoughtful research outcomes that benefit the scientific community as a whole (AlShebli et al., 2018; Garcia Martinez et al., 2017; Nielsen et al., 2017).

Among various approaches to utilize the potential benefits, the engineering education community has increasingly recognized that language use is one of the approaches to creating an inclusive and equitable learning environment (Jensen et al., 2021; Mary et al., 2021; Milligan et al., 2020). Language usage can either reinforce stereotypes and biases or challenge them, making it a powerful tool for promoting inclusion (Beukeboom & Burgers, 2019; Otterbacher, 2015; Sommer et al., 2019). Similarly, the way researchers communicate in academic settings - through research papers, conference proceedings, lecture interactions, and more, can significantly impact community-wise perceptions of a diverse and inclusive environment (Hymel & Katz, 2019; Juvonen et al., 2019). Although numerous studies have emphasized the critical role of language in shaping educational experiences and environments, there remains a need for more targeted and actionable research that especially focuses on language usage in the community.

In response to this awareness, there have been increasing calls for a more equitable and inclusive use of language in research practices. Recognizing the sophisticated impact that language has on shaping perceptions and either reinforcing or mitigating barriers, academia is placing greater emphasis on the adoption of more inclusive language practices. This study answers these calls by examining the current state and trends in language use within the engineering education research community, with a particular focus on the American Society of Engineering Education (ASEE) Conference and Expositions proceedings. Through an analysis of the language used in these proceedings from 2020 to 2022 based on the keyword-based model followed by the APA 7th language use guideline, the study seeks to determine the extent to which biased language continues to exist and identify areas for improvement. The results of this study are expected to contribute to a deeper understanding of the role that language plays in inclusion in the engineering education community. It aims to provide actionable insights for engineering educators and researchers to develop and nurture diverse and inclusive learning environments.

Background

The State of Diversity and Inclusion in Engineering Education Community

Diversity in modern education and research, especially in the field of engineering education, is critical to promoting academic equity and driving innovation (Direito et al., 2021; Farrell & Minerick, 2018; Hess et al., 2023). Studies show that an engineering education environment that is inclusive of diverse backgrounds and perspectives can significantly improve teaching quality and students' learning outcomes (Hess et al., 2023; King et al., 2021). Specifically, this diversity offers additional benefits. For example, diversity provides an approach where individuals can share and learn each other's perspectives based on their unique backgrounds, promoting innovative thinking and broader problem-solving approaches (Galinsky et al., 2015). Moreover, research demonstrates that diverse teams are better at solving complex problems than homogenous teams. This advantage has led to more effective research approaches

and comprehensive solution strategies, resulting in improved overall results and innovation in various engineering areas (Gyory et al., 2019; Mitchell & Boyle, 2015).

In addition to the points mentioned above, an inclusive learning environment encourages all students, including those traditionally underrepresented students to actively engage and contribute their unique perspectives (Penner, 2018; Theobald et al., 2020). This not only aids in the personal development of these students but also enriches the entire learning community's experience. In the meantime, increased diversity and inclusion help reduce socioeconomic disparities, and broaden participation and access for individuals who lack access to higher education resources, ultimately leading to society's overall engineering capacity (Delaine et al., 2016; Estrada et al., 2018; Johnson, 2019). Based on this rationale, promoting and maintaining diversity and inclusion in engineering is an ethical imperative and key to advancing scientific progress and societal development (Delaine et al., 2016; Williams et al., 2016). As a result, there is a growing focus on creating a diverse and inclusive environment in the engineering education research community.

The Role of Language in Engineering Education Inclusivity

In recent publications in the field of engineering education, researchers have emphasized that even implicit and unintentional linguistic biases can profoundly impact underrepresented groups, particularly in terms of feeling socially included or excluded (Aeby et al., 2019; Golbeck et al., 2016). These biases affect dimensions such as gender, race, ethnicity, and other social identities, thereby influencing diversity and inclusion in academia (Onyeador et al., 2021; Russell et al., 2019). For example, Degner et al (2019) found that the use of gender-specific language or the stereotyping of particular ethnic and racial groups may unintentionally convey a message of exclusivity, leading certain groups to feel marginalized in their engineering education studies and careers. Apart from that, such biases can be subliminally present in instructional materials, research papers, and everyday communications, leading to a persistence of bias that affects individuals' opportunities in a variety of settings (Llorens et al., 2021; Schnierle et al., 2019). In consequence, researchers and educators in the field of engineering education gradually realize that language choice and usage in academic settings and daily lives can shape whether an environment is perceived as diverse and inclusive (Lin, 2022; Mein & Esquinca, 2017). To address these challenges, numerous research publications emphasize the need for practical measures. These include reviewing and improving teaching materials and communication methods to ensure that these biases are not inadvertently reinforced (Jensen et al., 2021; Moschkovich, 2013). By taking these steps, a more equitable and inclusive environment can be created for all students regardless of their backgrounds.

Biased Language in Engineering Education: Current Trends and Implications

The importance of language use in the context of engineering education, especially in academic research and writing, is well supported by evidence (Bain Butler et al., 2014; Hirai et al., 2013; Sharma, 2018). An expanding body of research underlines that language serves as a medium for expressing ideas and knowledge and also for a variety of profound purposes (Bialystok, 1981; Hall et al., 2015; Jørgensen, 2008). For instance, Asian researchers tried to overcome cultural and linguistic discrimination in engineering education academic writing through advanced language skills (Tan et al., 2023). This approach demonstrates that language can be a useful tool that proves the effectiveness and professionalism in academic communication while fostering a welcoming environment. Moreover, the use of advanced

language showcases a deep knowledge of specialized professional and technical knowledge, demonstrating mastery and competence in the professional communities (Hundley & Brown, 2013; McDowell & Liardét, 2019; Tardy, 2020). This proficiency is particularly valuable in a globalized academic environment, as effective language use can help researchers overcome cultural differences, fostering communication and understanding among scholars from diverse backgrounds (Chambers, 2003; Yalcin, 2013). Therefore, the role of language is a powerful cultural and cognitive tool essential for promoting global academic communication and understanding cultural diversity in engineering education and the broad research community.

Despite growing awareness and efforts to enhance diversity and inclusivity, engineering education still faces systemic challenges, particularly regarding language biases in academic contexts. The persistence of these issues in academic discourse hinders the creation of inclusive learning environments, affecting the success of underrepresented groups in STEM fields. Consequently, there is an urgent need for research that moves beyond simply recognizing these issues. A holistic approach is required, one that involves identifying and analyzing linguistic biases.

American Psychological Association (APA) 7th Rules on Language Use

Recognizing that biased language in writing can lead to significant consequences, the seventh edition of the American Psychological Association's (APA) publication manual provides updated guidelines for language use (APA, 2020a; APA, 2020b). This latest edition reflects the growing scholarly recognition of language's role in impacting diverse populations, particularly in how bias and discrimination can be minimized through careful language choices and expressions. For instance, the manual advocates for the use of gender-neutral language and advises against stereotypes based on gender, race, and cultural background, among other dimensions (APA, 2020a; APA, 2020b). Furthermore, this updated version of the APA manual aligns with the organization's commitment to addressing issues of diversity, inclusion, and nondiscriminatory practices. It encourages scholars and researchers to carefully consider how their language may affect readers and the groups they study when composing papers and reports (Etengoff, 2023). In our study, we adhered to the APA 7th language guideline to define the biased language for the keyword-based model, assessing whether language usage in the engineering education community has evolved in recent years.

Conceptual Framework

This study employs a conceptual framework that integrates implicit bias theory with academic literacy theory, offering comprehensive perspectives to examine language use in the engineering education community and its broader sociocultural implications.

Firstly, implicit bias theory lays the groundwork for examining unconscious attitudes and stereotypes that subtly, yet significantly, influence language use in academic settings (Brownstein, 2019). Originating from cognitive psychology, this theory uncovers how biases, often unconsciously activated, can influence our decisions and actions without our full awareness (Brownstein, 2019; Greenwald & Banaji, 1995). In the field of engineering education, this theory illuminates the subtle ways in which stereotypes are inadvertently perpetuated and exclusions are created through linguistic expressions. This aspect is particularly pertinent in STEM fields, where diversity and inclusion are both critical and challenging to achieve (DeCuir-Gunby & Bindra, 2022; Greenwald & Banaji, 1995; Payne & Hannay, 2021). Utilizing implicit bias theory to recognize and address these potential biases in academic discourse is essential for promoting

of a more inclusive educational environment and contributes to creating a more equitable atmosphere.

Complementing implicit bias theory, academic literacy theory provides insights into the practices and conventions of communication within academic contexts (Clarence & McKenna, 2017; Lea & Street, 2006). Academic literacy theory posits that literacy practice in academic settings is a tool for transmission of knowledge and also a medium for the negotiation and expression of power dynamics and cultural values. Tracing back to linguistics and education fields, this theory underscores the acquisition and use of literacy practices, which are influenced by, and in turn, influence the norms and values of academia (Lea & Street, 2006; Lillis, 2019). Applying this theory to our study, we gain a deeper understanding of how language in engineering education serves not just as a medium for information exchange, but also as a potent tool for embodying and reinforcing academic norms. It enables us to analyze how academic publications in engineering education may consciously or unconsciously reinforce existing biases and stereotypes, thus affecting the inclusiveness of the academic community.

By integrating these two theories, our study's framework allows for a nuanced exploration of the intersections between unconscious bias in language use and the conscious practices of academic language use. This dual perspective contributes to enhanced perceptions of the dynamics of language use in engineering education research, helping to identify the ways in which language not only reflects but may also perpetuate social biases, and how academic teaching frameworks and literacy practices can be reformed to promote more inclusive and equitable engineering education, and potentially, in broader educational environments.

Data and Methods

This study undertook a comprehensive analysis of language use within the engineering education research community. Data were sourced from the proceedings of the American Society for Engineering Education (ASEE) conference and exposition spanning the years 2020 to 2022. A total of 5,237 published conference proceedings were extracted and analyzed for this purpose. These proceedings constitute a significant portion of current scholarly research in engineering education and offer a robust foundation for examining trends in language use over this three-year period.

To identify biased language, we utilized a keyword-based model, drawing keywords from the language guidelines of the APA 7th edition, which emphasize the importance of inclusive and bias-free language. We identified 85 keywords that could potentially induce bias, categorizing them by subject area in engineering education, as detailed in Table 1. This approach led to the initial identification of 5,134 potential instances of language bias. A subsequent manual review was then conducted to exclude cases where the keyword usage was not problematic, such as when "the Elders" is used as a last name, or "females" and "males" are appropriately used when the reference groups include individuals with a broad age range. Following this review, 4,800 instances were confirmed as actual examples of biased or non-inclusive language use, demonstrating a 93.5% in-sample precision rate for our keyword-based model.

Table 1

Biased Language Keywords Categorized by Subject Area in Engineering Education

Category	Keywords
Age	the elderly, elders, elderly people, the aged, aging dependents, senior citizens, old men, old women, senility, senile
Disability	Special needs, physically challenged, mentally challenged, mentally retarded, mentally ill, handi-capable, deafness, is deaf, hearing-impaired, with hearing loss, visually challenged, sight-challenged, with blindness, wheelchair-bound, AIDS victim, brain damaged, cripple, alcoholic, meth addict drug addict
Gender	Mankind, man-machine interface, manpower, females/males, preferred pronouns, mothering, foreman, housewife, mailman, salesman, stewardess, waitress, chairman, opposite sex, opposite-gender couples
Race and Ethnic Identity	Afro-American, Orientals, Caucasian, Eskimos
Sexual Orientation and Gender Diversity	Homosexual, homosexuality, sexual intercourse, birth sex, natal sex, born female, born male, born a girl, born a boy, hermaphrodite, tranny, transvestite
Socioeconomic Status	The undocumented, illegal aliens, illegal immigrants, the poor, low-class people, poor people, the homeless, the ghetto, the inner city, welfare mothers, welfare reliant, high-school dropouts, achievement gap
Other	abusive relationship, prostitute, prisoner, slave, committed suicide, failed/successful suicide, failed suicide, completed suicide, sex with an underage person, nonconsensual sex

Next, our analysis focused on identifying unique cases of biased language. In this study, a unique case was defined as an instance where a specific biased keyword or phrase appeared within a paper. For example, if a paper contained both “abusive relationship” and “achievement gap”, each term was counted separately, contributing two unique cases to the total count. However, repeated occurrences of the same term within a single paper, such as “achievement gap” appearing multiple times, were counted as one case. This approach was implemented to avoid overrepresentation of a single type of bias within any paper. Following this methodology, from the initially identified 4,800 cases of biased language, the number was refined to count only unique instances of each term per paper, which reduced the total to 936 cases.

In this study, our primary objective was to conduct a descriptive analysis to examine the distribution of identified keywords by year and by their respective categories. This was done in order to understand the nuanced patterns of biased language usage within the engineering education community. To achieve this, we categorized each instance of biased language, noting its frequency and specific context. We then analyzed trends over the three-year period, looking

for any shifts or changes in the usage of these keywords. This analysis was crucial for comprehending the prevalence and the evolution of biased language in academic discourse over time.

Furthermore, we implemented an association rule analysis to examine the intersectionality of biased language use. This involved an exploration of instances where an individual uses a specific category of biased language while simultaneously employing other biased terms. Our focus was on understanding the complex relationships and potential correlations between these terms. For example, if a researcher frequently uses terms associated with gender bias, our analysis investigated whether there is a propensity for them to also use terms related to racial or ethnic biases. This approach allowed us to explore whether certain biases are interconnected or exist in isolation within academic discourse. Our study aimed to provide a holistic and detailed understanding of biased language patterns and their interactions within the engineering education research community.

Results

As highlighted in Table 2, the analysis of the proceedings from 2020 to 2022 shows a modest decrease in the number of unique cases of biased language, declining from 359 cases in 2020 to 283 in 2022. Concurrently, the number of conference proceedings each year remained relatively stable, with counts of 1,773 in 2020, 1,712 in 2021, and 1,752 in 2022. This slight downward trend in biased language cases may suggest a minimal shift toward more inclusive language use over time. However, the consistently high number of annual instances underscores that biased language remains a prevalent and significant issue in academic writing within the engineering education field. The data indicates that, although there might be some progress, the use of biased language is persistent and may require more substantial efforts and time to reduce significantly.

Table 2

Number of Conference Proceedings and Unique Cases of Biased Language by Year

Year	Unique Cases of Biases Language	Number of Conference Proceedings
2020	359	1773
2021	294	1712
2022	283	1752

Table 3

Annual Trends in Biased Language Categories

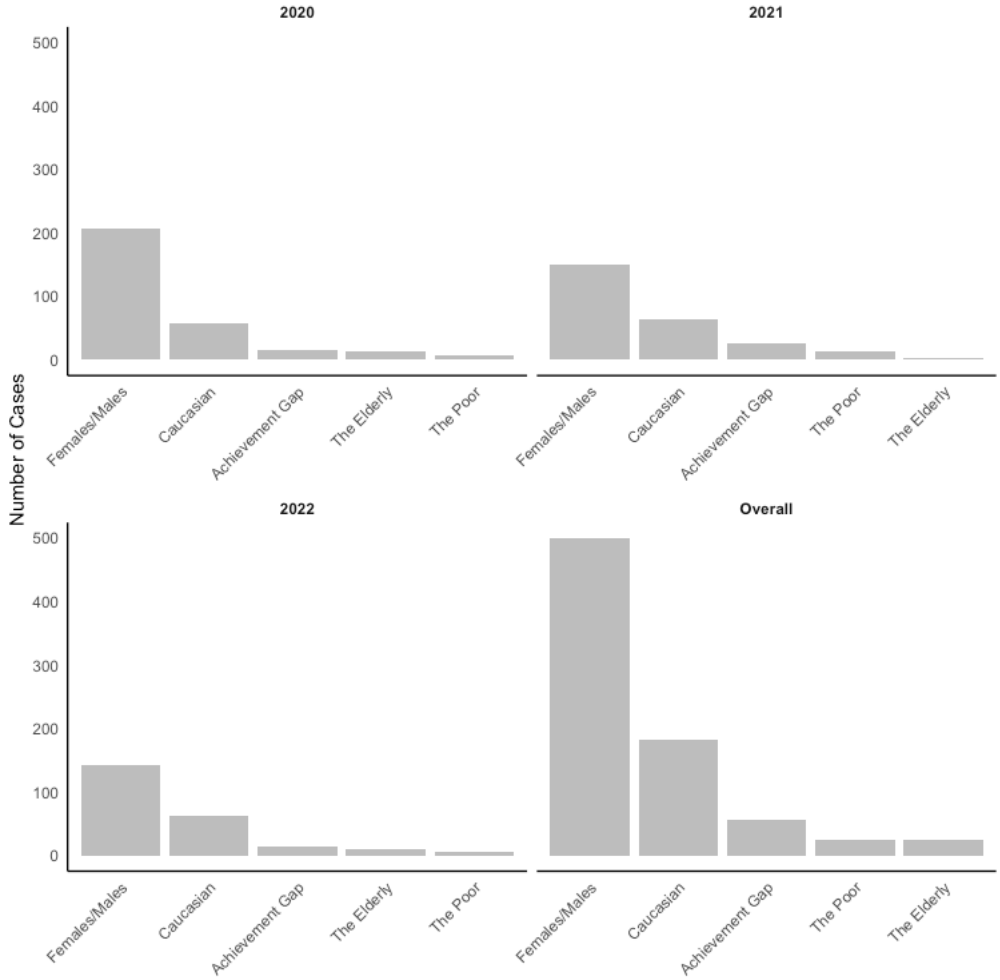
Year	Age	Disability	Gender	Other	Racial and Ethnic Identity	Sexual Orientation and Gender Diversity	Socioeconomic Status
2020	17	16	233	4	58	1	30
2021	10	8	158	8	65	0	45
2022	19	8	163	7	62	4	20

Table 3 presents a detailed breakdown of biased language cases by category and year, spanning from 2020 to 2022. The categories are Age, Disability, Gender, Other, Racial and Ethnic Identity, Sexual Orientation and Gender Diversity, and Socioeconomic Status, aligning with the keywords defined in Table 1. In 2020, the most prominent category was Gender, accounting for 233 cases, followed by Racial and Ethnic Identity with 58 cases, and Socioeconomic Status with 30 cases. There were also notable instances in the Age and Disability categories, with 17 and 16 cases respectively, and a single case related to Sexual Orientation and Gender Diversity. The year 2021 saw a significant decrease in the Gender category to 158 cases, and an increase in Socioeconomic Status-related cases to 45. The Racial and Ethnic Identity category remained consistently high with 65 cases. In 2022, there was an increase in Gender related cases to 163. Age-related cases rose to 19, and there was a concerning increase in cases related to Sexual Orientation and Gender Diversity, marking 4 cases, which was more than the previous two years combined. The Socioeconomic Status category saw a decrease to 20 cases, and the Disability category remained consistent with 8 cases.

The analysis of these trends reveals some important patterns and shifts. The persistently high number of cases in the Gender category across all three years underscores a continuous challenge in addressing gender biases within the engineering education community. The increase in cases related to Sexual Orientation and Gender Diversity in 2022, though small in number, may suggest a growing awareness or increased reporting of issues in this area. Conversely, the notable decrease in Socioeconomic Status cases from 2021 to 2022 could indicate an improvement in addressing economic disparities in language use, or changes in the themes of conference submissions during those years. The consistent presence of cases in Racial and Ethnic Identity category over the years points to ongoing challenges in fully integrating racial and ethnic diversity in academic discourse. These trends and fluctuations offer valuable insights into the evolving nature of language use in engineering education and highlight the need for continued attention and efforts toward achieving truly inclusive academic communication.

Figure 1

Top 5 Biased Language Keywords by Year



Additionally, our detailed examination, presented in Figure 1, uncovers notable patterns and trends in the top 5 keywords usage. Especially, the keyword “females/males” emerges as the most frequent case with a total count of 499 across the period, indicating a prevalent focus on gender dynamics within academic discussions. Conversely, terms like “the poor” and “the elderly” receive considerably less emphasis respectively as 25 and 24, pointing to potential areas for broader engagement and discourse within the field. Further analysis revealed a noticeable decline in the use of “females/males” through the years indicating a possible shift toward language that is more inclusive and neutral. Meanwhile, the consistent mention of “Caucasian” across the years points to the ongoing discussion of race identity that should be paid more attention to in academic writing. The fluctuation in the term “achievement gap”, especially its surge in 2021, might reflect the academic community’s heightened attention to disparities in educational outcomes. In addition, the order of keywords changes in the year 2021, “the elderly” dropped to fifth place behind the term “the Poor”, overall counts also indicate the term of using “the poor” is slightly more than “the elderly”.

Finally, as an additional preliminary analysis, we explored potential associations between various categories and keywords to uncover patterns in the use of biased language. This

examination revealed clear association rules linking specific categories or keywords. For instance, we observed a notable tendency for authors who used biased language in the gender category to also employ terms from the race/ethnicity category, and vice versa. This pattern suggests a potential interconnectedness or co-occurrence of these bias categories within the authors' language. Furthermore, these association rules are evident in the use of certain keywords as well. For example, the term "achievement gap" was often found to be used alongside the term "Caucasian", suggesting a potential reciprocal relationship between these specific biased keywords. Such patterns underscore the complexity of biased language use, indicating that it involves intertwined layers of biases within academic discourse.

Discussion

The findings from this study highlight the persistent issue of biased language within the engineering education community, notably in the categories of gender and racial identity. The continued use of terms that may be considered offensive or exclusionary in academic writing underscores the urgency for a shift toward more inclusive practices in academic environments. In the meantime, the promotion of APA 7th language usage guideline is imperative because the current research contexts although gradually have the sense of awareness of using biased free language in academic writing, there is still a gap for individuals to get familiar with the guidelines and certain linguistic habits remain deeply ingrained within the academic writing culture of engineering education. This persistence proves existing evidence from the literature, which suggests that biases in language are not quickly or easily eliminated (Hyland, 2004; Lee & Casal, 2014). Moreover, several studies have repeatedly shown that the use of biased language can significantly impact the sense of belonging and participation among underrepresented groups, potentially hindering their academic and future career progression within these fields (Llorens et al., 2021; Penner et al., 2021). Furthermore, the resilience of gender and racial biases in language use over the years indicates a broader systemic issue that is beyond personal consciousness, reflecting structural aspects of academic culture that need comprehensive strategies for change (Fan et al., 2019; Files et al., 2017). Therefore, the findings of this study not only reaffirm the need for continued investigation into language use within academic environments but also call for the implementation of robust measures to foster truly inclusive space in engineering education.

Our results align well with the conceptual frameworks employed in this study. They reflect implicit biases in language use and demonstrate their significant impact on perceptions and attitudes in the academic community. Additionally, these findings resonate with academic literacy theory, which posits that language is not merely a tool for communication but a carrier of cultural and disciplinary values that shape identities within academic contexts. By highlighting the persistence of implicit biases in language, this study underscores the theory's assertion that language practices can subtly influence inclusivity and equity in educational environments. This underlines the critical need for proactive efforts to promote inclusive language practices in engineering education. Overall, our findings underscore the necessity of deliberate actions to counteract these biases, following the guidelines for inclusive language set out in the APA 7th edition. This approach is essential not only for fostering a more inclusive academic environment but also for shaping a more equitable and diverse future in the field of engineering education.

In addition to that, the intersectionality of gender and race categories significantly compounds the challenges faced by underrepresented groups. Numerous studies have consistently highlighted how the interplay between gender and racial identities can amplify the

experiences of bias and exclusion (Killen, 2007; Killen et al., 2022). This intersectional perspective suggests that the impact of biased language is not only additive but multiplicative, exacerbating barriers to creating diverse and inclusive academic communities. Our findings contribute to this standpoint by demonstrating that linguistics biases, particularly those related to gender and ethnic identity, not only persist but continue to shape perceptions and attitudes within the engineering education community. From teaching and learning perspectives, instructors should take the study findings to deepen their understanding of how language bias impacts students from multiple marginalized. In the meantime, educators and researchers should design and implement inclusive teaching practices to make people aware of the role that languages play in creating an inclusive atmosphere. This underscores that when addressing the problem of bias in language, individuals need to think carefully and holistically to understand various ideas between different populations, in particular, those who belong to multiple marginalized groups at the same time. This is to ensure that measures to promote inclusion effectively reach those who live in particularly complex situations. In other words, the issue of language bias usage is thoughtful and comprehensive progress, ensuring that everyone feels included and respected is needed.

Limitations and Further Directions

While this study offers quantitative insights into language bias in the engineering education community, it contains several limitations. Firstly, it is focused on the ASEE conference proceedings, which may not fully cover represent language practices across the broader engineering education discipline. Additionally, our analysis relied on a keyword-based model to detect biased language. While effective in identifying explicit cases of bias, this approach may overlook more nuanced, context-dependent language biases. The interpretations of language choices can vary widely depending on cultural, disciplinary, or situational contexts. For example, some biased words cannot be identified as biased within the specific writing contexts, or biased language can be the authors' last name in certain cases. Therefore, a more extensive manual review might be necessary to validate the automated model's findings, acknowledging that this introduces a subjective element.

Therefore, there are several directions for future research. First of all, future studies should aim to broaden the analytic scope by incorporating a broader range of academic publications and conference proceedings, rather than focusing solely on a single engineering education conference. Second, future studies could improve by employing more advanced and context-aware language analysis tools, which can potentially improve the detection of subtle language biases. For example, using cutting-edge analytical methods including natural language processing (NLP) could enhance analysis accuracy and contribute to enhancing the overall diverse and inclusive learning environment. Beyond these considerations, extending the analysis to include academic writing materials from additional years could provide a more comprehensive view of how language practices evolve over time. This could offer deeper insights into the effectiveness of initiatives focused on fostering inclusive language use.

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