Beyond the Binary: Interdisciplinary Approaches to Trans Contexts

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How we talk about trans people: A content analysis

Introduction and Background

Transgender, nonbinary, and gender nonconforming (TNBGNC) individuals stand at the intersection of resilience and systemic oppression in STEM higher education, revealing urgent gaps in how research methodologies we utilize capture and represent their experiences. The identities of TNBGNC individuals have been subject to systemic marginalization, often fueled by politicized rhetoric and harmful media narratives [1], [2], [3]. This discourse frequently perpetuates the stigmatization and devaluation of TNBGNC lives and experiences, framing them in opposition to the societal norms. Such framing not only erases the diversity of TNBGNC experiences but also undermines their legitimacy and humanity. Research on TNBGNC individuals has frequently reflected these societal biases, employing overly reductive methodologies that fail to capture the complexities of their lived realities [4]. This underscores the need for a paradigm shift in research approaches- particularly within engineering education and STEM fields more broadly- to ensure that the knowledge we produce uplifts and empowers the TNBGNC community. Drawing on the interdisciplinary insights of trans studies, researchers can adopt theoretical frameworks and methodologies that challenge the cisheteronormative assumptions that dominate our field while prioritizing research outcomes which foster TNBGNC belonging and persistence in their studies.

Trans studies provides critical tools for interrogating and dismantling systems of power that perpetuate the marginalization of TNBTNC individuals. Trans studies emerged as a field of study in the early 1990s within the contexts of feminist and queer theory, and centers on the transgender struggle for social justice [5], [6]. This is not to say that trans studies is merely a subcategory of feminist or queer theory, as many trans studies scholars have argued against [5], [7], [8], but rather to assert that trans studies is a discipline that provides space for trans knowledge and the voices of trans theorists that were silenced in the formation in of the aforementioned academic spaces. Current trans studies discourse extends these critiques by branching into epistemic justice, intersectionality, and interdisciplinary applications [9], [10], [11]. By employing trans studies frameworks, STEM and engineering education researchers can move beyond tokenistic inclusion to foster genuine collaboration with the TNBGNC community. Such approaches not only enhance the validity of research findings, but also align scholarly practices with our discipline's values of equity and justice.

In STEM education, existing literature offers insights into the experiences of TNBGNC students, however epistemological and methodological approaches to studying trans students are seldom discussed. Studies have highlighted the lived experiences of TNBGNC students barriers to retention and the importance of emotional and instrumental support (see [12] - [15]). However, much of this research generalizes the larger LGBTQ+ experience and relies on established frameworks utilized in the STEM and engineering education space (e.g., queer theory, social capital theory). Therefore, outside of a select few exceptions (see [16], [17]), the research of trans scholars in trans studies has seldom been utilized to understand the lived experiences of our TNBGNC peers in STEM. We believe that the use of trans studies frameworks and methodologies in STEM and engineering education research with the TNBGNC community can

enrich current discourse by fostering a deeper understanding of the transgender experience and create pathways to transform educational practice.

If we, as engineering education researchers, want to better understand the experiences of TNBGNC students, validate their identities, and support their pursuit of engineering degrees, we must understand the traditional pitfalls of research with the trans community and the ways by which trans scholars suggest we move forward. Trans studies as a field was created to foster discourse within the trans community regarding the sociopolitical and cultural dimensions of gender and identity and provides tools to critically examine systemic inequalities and epistemological biases. By engaging with these tools, we can interrogate the structural barriers that TNBGNC students face in STEM education and develop research practices that prioritize their voices and lived experiences. This work necessitates not only a reevaluation of existing frameworks but also a commitment to collaborative methodologies that empower the TNBGNC community as co-creators of knowledge. Guided by these imperatives, we ask: *How can the integration of trans studies frameworks into engineering education research improve the representation and inclusion of TNBGNC individuals in engineering and STEM more broadly?*

Methods

Nomenclature

In this paper, we use several terms that require clarification to ensure consistency. We use the term transgender, nonbinary, and gender nonconforming (TNBGNC) to collectively describe individuals whose gender identity or expression differs from societal norms associated with their sex assigned at birth. It is an umbrella term which encompasses transgender, nonbinary, genderqueer, genderfluid, and other gender identities that challenge the binary gender norms. Cisheteronormativity is the expected normalcy of cisgender and heterosexual gender roles, or cisgender norms (e.g., Men traditionally wear a suit and tie to show professionalism) [18] . Otherization is term we use to describe the phenomenon of defining an out-group who does not fit neatly within societal norms [19]. These definitions reflect the critical vocabulary of this paper, aimed at fostering understanding and inclusivity within discussion of TNBGNC research in engineering and STEM education.

Authors Positionality

Due to the politicization and marginalization of the TNBGNC community, our research team recognizes the importance of critically reflecting on our positionalities and how they influence our interpretations of trans studies and STEM education research. The first author is a nonbinary student pursuing their doctoral degree in engineering education at a large midwestern research-intensive (R1) university. They have a background in engineering from an R1 engineering-focused institution and their lived experience as a nonbinary engineer shapes their understanding of their perceptions of trans studies research and the conduct of STEM education research on the TNBGNC community. The second author is a tenured woman faculty-members at a large midwestern R1 university. As an ally of the TNBGNC community and the LGBTQ+ community more broadly, she is committed to advancing research that supports the equity and inclusion of the TNBGNC community in engineering. Collectively, we aim to conduct research that amplifies

TNBGNC perspectives, challenges reductive frameworks, and contributes to more equitable engineering education practices.

Data collection

For our study, three papers were selected from STEM education and trans studies disciplines. The papers selected from trans studies were selected based on their relevance to inform the research direction of STEM education researchers, and emphasis was given to those written by influential authors in trans studies. Papers were selected from two dedicated trans studies journals, while one paper was selected from a trans studies special edition of an education journal. Papers we selected from STEM education were chosen due to authorship by high impact, well respected authors of LGBTQ+ studies. Papers were selected from the larger STEM education field instead of engineering education due to the limited body of engineering education research on the experiences of TNBGNC students. A detailed list of the papers reviewed can be seen in tables 1 and 2. This selection of papers was assembled to create dialogue between the current state of TNBGNC research in STEM education and the discourse of trans studies authors.

Table 1

Summary of trans studies papers reviewed

Title	Authors	Journal	Subject
Methodology as pedagogy: Trans lives, social science, and the possibility of education research	Keenan	Special Edition Journal of Educational Research	Applications of trans studies methodologies to inform methodologies in educational research
On trans* epistemology	Radi	Transgender Studies Quarterly	Applications of trans studies discourse in research on trans communities
Oppressive pushout: Examining differences in discipline and "dropout" by race, gender, and sexual orientation	Aguilar et al.	Journal of Queer and Trans Studies in Education	How the intersections of race, gender, and sexual orientation contribute to K-12 pushout

Table 2

Summary of STEM education papers reviewed

Title	Authors	Journal	Subject
Finding community and overcoming barriers: experiences of queer and transgender postsecondary students in mathematics and other STEM fields	Kersey and Voigt	Mathematics Education Research Journal	How gender identity affects experiences and persistence in STEM
Factors influencing retention of transgender and gender	Maloy et al.	CBE—Life Sciences Education	How the persistence of TNBGNC students compares to other

nonconforming students in undergraduate STEM majors			underrepresented minorities and cis peers
Queerness in science, technology, engineering, and mathematics (STEM): insights and foresights from experienced lesbian, gay, bisexual, transgender, queer, and plus (LGBTQ+) advocates	Cross et al.	Journal of Diversity in Higher Education	How LGBTQ+ allies become allies and integrate that identity into their personal and professional responsibilities

Data analysis

Once papers were chosen, we read and analyzed holistically following Nicmanis's [20]) reflexive content analysis approach. Reflexive content analysis emphasizes the importance of how preexisting knowledge, experiences, and sociohistorical-political contexts influence a researchers' engagement with the research process and decision-making. The authors chose to utilize this flexible research-oriented method to study the explicit and manifest qualitative data presented in the chosen articles. By using a method that focuses on the explicit statements made in an academic article, with emphasis on criticality and researcher reflection, emphasizes how trans studies can guide TNBGNC research in STEM education. Papers from trans studies were analyzed for actionable manifest content regarding the current discourse of TNBGNC research practices. Papers we selected from STEM education were analyzed for their alignment to the discourse of trans studies scholars, and how STEM education researchers navigate work with the TNBGNC community. This preliminary analysis, combined with consistent memoing throughout the analysis process, formed the basis for a comparison of conversations across the two disciplines to provide recommendations on how STEM and engineering education researchers can best incorporate the trans studies discourse into their work.

Quality and academic rigor

To ensure qualitative rigor, we follow Walther et al.'s [21] qualifying qualitative research quality (Q^3) framework. The Q^3 framework's emphasis on reflexivity coordinates with reflexive content analysis and centers the impact of prior experience and societal conditioning in our research process. While we recognize the shortcomings of utilizing the Q^3 framework, it is widely recognized as an appropriate method of analyzing qualitative research quality in engineering education. We assured theoretical validity in our study by purposefully sampling articles from trans studies that best aligned with educational practices and by choosing STEM education papers written by authors recognized for their work with the LGBTQ+ community. We ensured communicative and procedural validation by engaging with both the trans studies and STEM education articles simultaneously and iteratively investigating the relation between both disciplines throughout the analysis process. In addition, we accounted for pragmatic validation through ensuring that our interpretation of our findings would be applicable in progressing our ability to conduct TNBGNC research in STEM and engineering education.

Limitations

While we believe that the findings and interpretations are actionable and provide guidance on conducting TNBGNC research in engineering education and STEM education more broadly, we recognize that our study has limitations. Our study is limited in scope by the articles analyzed in both trans studies and STEM education. While every effort was made to provide a meaningful synthesis, the breadth of literature reviewed constrains the conclusions drawn. The fields of trans studies and STEM education are both expansive, and we believe the papers we chose for analysis accurately reflect the discourse on researching the TNBGNC in STEM. Additionally, because this study addresses TNBGNC research in STEM education, rather than specifically engineering education, we are unable to draw nuanced conclusions specific to conducting TNBGNC research. However, given the overlap between research practices in STEM and engineering education, we anticipate that our findings will be broadly applicable to TNBGNC research within engineering contexts.

Findings

When discussing how transgender participants are treated in research, Radi describes the epistemic practice of othering; or how trans people are perceived by many to be distinctly antithetical to cisgender norms, and "implicitly excluded and inferior" to their cisgender peers [22, p. 49] . Radi explains how this process creates an "us" versus "them" mentality, which facilitates a distancing of the researcher and their audience from their participants. Such a mindset encourages skepticism regarding the legitimacy of narratives shared by transgender participants, which devalues their experiences in the eyes of the cisgender "us". This "us" versus "them" mentality is readily perpetuated throughout the U.S. education system, which Keenan argues, "has largely reinforced prescriptive and inflexible structures of gender governance … as an explicit means to socialize children into Eurocentric gender norms" [23, p. 311] . It is no surprise, then, that cisgender researchers would see those that do not adhere to the Eurocentric gender norms as somehow different to themselves. The otherization of transgender participants in research contributes to how researchers ask questions, select methodologies, and analyze information, negatively polarizing our understanding of the TNBGNC community.

TNBGNC involvement in research

We, in our practice as researchers, have served to perpetuate the otherization of the TNBGNC community in our work both willingly and unwillingly. Researchers have left little space for the input of trans scholars in trans discourse. This "unequal relationship in the production of knowledge" [22 , p. 48] furthers the objectification of the trans community, where they are "treated as mere objects- where 'mere' signifies a more general denial of their subjectivity" [24, p. 133] . The mere objectification of trans participants and the knowledge they create leads to the infantilization and pathologization of the trans populous and devaluation of the trans experience. This results in the "genders of trans people [being] turned into matters whose credibility requires the opinion of various (cis) intellectual authorities" [22, p. 49]. The problematization of trans identity shifts trans discourse away from addressing systemic causes and towards problematizing the trans individual.

A lack of trans researchers in positions of academic authority would result in research that does not fully account for the nuances of the trans experience and perpetuate trans otherization. Of the STEM education papers reviewed in this study, two studies included authors who identifies outside of the gender binary [25], [26], where one author was a nonbinary graduate student, and another was a nonbinary tenure-track faculty member. Working with TNBGNC research team members when conducting research on the trans community assists in preventing the otherization of the trans participants not only in data collection and dissemination, but in the questions asked and methods used. In addition to working with TNBGNC team members, most authors on the STEM education studies reviewed identify as members of the larger LGBTQ+ community. Through their positionality statements, cisgender researchers working on these studies also discussed utilizing member checking [25], [27] to involve participants from the trans community in the formation of their findings, while all described how their positions in the LGBTQ+ community influences their understanding of the larger queer experience [25] – [27]. By involving TNBGNC researchers at every level of the research process and encouraging the use of member checking allows for researchers to study the experiences of the trans community in STEM without otherization.

Against the gender binary

While those involved in the research process can guide the direction of research towards findings that benefit the TNBGNC community, the methods they utilize can limit the effectiveness of their work. Trans studies as a discipline engages in critical discussions around research methodologies and their use as tools to enforce established power dynamics. Aguilar et al. problematize the use of secondary data in which "gender and sexual orientation are frequently purported as neat categories" or "conflates sex … with gender identity" [28 , p. 4]. They explain that the oversimplification and equivalence between sex and gender "reifies the notion that sex is indicative of one's gender", which calls into question the validity of trans identities [28, p. 5]. Keenan raises a similar criticism regarding the research conducted by cisgender researchers traditionally treats trans participants. Specifically, he brings to attention the willingness of the cisgender research community to treat sex and/or gender as binary variables in quantitative studies and as "a simple matter of visual observation" in qualitative work for the sake of efficient analysis [23, p. 308]. The reductive binary understanding of gender is twofold in its service against the TNBGNC community. Not only does an oversimplification of gender forego the rigorous academic discussion of the experiences of TNBGNC individuals and how they compare to those of their cisgender peers; it also delegitimizes other gender identities (e.g., trans, nonbinary, genderfluid) that fall outside of the overly simplistic framework. In the perpetuation of the gender binary, TNBGNC "identities and experiences have become instruments of scorn and exclusion" where they are perceived through subversion of inflexible- preexisting- gender categories [22, p. 50]. The view that TNBGNC individuals are defined by their transgression of gender roles otherizes them against the normative expectations of a cisgender society.

In STEM education studies on TNBGNC students, researchers still often fall into the pitfalls of assigning TNBGNC individuals into dichotomous categories, forgoing critical discussions of gender in favor of simplistic, generally quantitative, analysis. Kersey and Voigt navigate this

discourse by problematizing binaries such as gay/straight, cisgender/transgender, and even binary/nonbinary, but recognize that as researchers "such distinctions are necessary in order to make meaningful comparisons" [27, p. 737]. In this manner, the authors acknowledge the nuances of gender identity and the limitations of the methods they choose to utilize. However, through their wariness to define binary relations, Kersey and Voigt choose to "use the terms sex/male/female interchangeably with gender/man/woman" and justify their choice by claiming that "sex roles and gender roles are closely intertwined and to distinguish between the two is to create a false binary" [27, p. 737]. The authors conflate sex and gender and forego the nuanced conversation they attempt to preserve through acknowledging by problematizing binaries in participant gender identities. Instead, unintentionally reinforcing biological determinism and conflating biological attributes (sex) to social, cultural, and psychological roles (gender). Cross et al. [25] pursue a different approach afforded to them through their use of phenomenological methods by allowing participants to self-report their gender identity, then obfuscating that information in direct quotes made by the participant to protect them from reidentification. This method of representing gender information was useful in their study because their findings are actionable in support of the larger TNBGNC community, opposed to describing identity-based lived experiences. Maloy et al. were limited in their data collection and representation, as they utilized a preexisting data set, however they clearly identify the limitations of the survey with respect to capturing the broad spectrum of TNBGNC identities [26, p. 6]. While STEM education researchers take additional care to ensure the identities of TNBGNC participants are accurately represented in their studies, they still encounter difficulties accurately reflecting the nuance of gender because of methodological limitations.

Intersectionality

Trans otherization is also contributed to by the inseparability of gender and race. While the TNBGNC community more broadly faces a plethora of challenges which perpetuate their otherization, this is compounded by hegemonic whiteness which reinforces Eurocentric norms of gender identity, marginalizes intersectional experiences, and privileges cisgender white perspectives as the default in research, education, and societal structures more broadly. Keenan describes how historically, gender nonconformity has been perceived as a "threat to the preservation of white supremacy through heterosexuality" [23, p. 309], and explains how gender legitimacy is constantly framed through the lens of racial legitimacy. Thus, it is impossible for us to draw conclusions that account for the experiences of all members of the TNBGNC community without recognizing the role of racial prejudice in shaping their lived experiences, perpetuating systematic inequalities, and intersecting with gender identity to create unique forms of marginalization and exclusion. Radi explains how early trans studies work often speaks "to the entirety of the trans community, although … it could certainly be enriched through intersectional approaches that take into account multiple axes of subjection, such as class, nationality, or age" and encourages "more nuanced work, able to deal simultaneously with various relevant distinctions" [22, p. 46]. Aguilar et al. highlight this nuance in their research on queer and trans Black, Indigenous, Students of Color (QT BIPOC), taking into consideration the inseparability of gender and race, stating "their intersecting identities make them vulnerable to violent systems of oppression such as racism and cisheterosexism" and that the "cumulative nature of their

identities marginalize them from the hegemonic stronghold of white supremacist cisheteropatriarchy in schooling" [28, p. 4]. When we, as researchers, fail to identify the inseparability of systems of oppression, we do a disservice to that belong to multiple marginalized communities.

In STEM education, navigating the nuance of combined racial and gender identities is difficult due to our discipline's historic struggles with both racial and gender diversity. While some studies discuss the experiences of underrepresented minorities and TNBGNC students, these demographics are often treated as distinctly separate groups (see [26]). This is often due to the limited size of the BIPOC TNBGNC cross-tabulation creating difficulties for making statistically significant quantitative claims. In addition, the tentativeness for STEM education to embrace qualitative research on the experiences of BIPOC TNBGNC students creates a dearth of literature on their experiences in STEM. Cross et al. discuss the importance intersectionality in their study, stating "possessing multiple marginalized identities leads to unique experiences of marginalization, encompassing ideas of both additive stress and resilience" [25], [29]. By incorporating this consideration within their theoretical framework, the authors collect and interpret the experiences of their participants without obfuscating the importance of intersectional identities.

Discussion and Recommendations

Amongst discussions of politics, transgression, and human rights, trans studies scholars are actively engaged in discourse around the way we conduct research on and with the TNBGNC community. This discourse brings attention to the otherization of the TNBGNC community and the devaluation of the lived experiences of trans participants, while also providing guidelines and recommendations for improving the ways we conduct TNBGNC research. Trans studies authors have raised concerns over how little space has been given to TNBGNC scholars in the creation of knowledge that informs, empowers, and uplifts the TNBGNC community. They explain how reductive analysis of gender in research can lead to the conflation of sex with gender and the perpetuation of biological determinism. In addition, they discuss how the current state of trans research fails to engage meaningfully with the intersections of multiple minoritized identities.

While the body of trans research in STEM education is limited, researchers have done well with the tools available to depict the experiences of the TNBGNC community without otherizing or otherwise illegitimizing their identities. Notable authors in the LGBTQ+ STEM education space have included the TNBGNC researchers in the process of design and dissemination, which has contributed to language and findings that do otherize the TNBGNC community. In addition, these authors have cautioned about creating false gender dichotomies and have problematized secondary data sets where this is present. STEM education authors also recognize the inseparability of marginalized identities in how communities experience the world around them. However, as with all research, we can improve our frameworks and methodologies to create increasingly actionable work that respects and uplifts the TNBGNC community.

We recommend researchers participate in collaborative partnerships with TNBGNC researchers and members of the larger TNBGNC community throughout the research process to ensure that

knowledge gained will be of benefit to the TNBGNC community in pursuit of their STEM degrees. One of the most compelling reasons to integrate trans studies work into TNBGNC research in STEM and engineering education is to navigate trans community involvement in academic research. Radi suggests that involving trans scholars in work outside of trans studies is doubly beneficial, as not only are TNBGNC community experts in their own experiences, but also see the privileged lives of their cisgender peers from the outside, which research conducted solely by cisgender researchers cannot address [22]. While many STEM education researchers include members of the trans academic community in their work, there is still room for increased involvement at all steps in the research process to ensure actionable outcomes that benefit the TNBGNC community.

In addition to creating actionable findings, we recommend STEM and engineering education scholars embrace the problematization of dichotomous gender variables and the conflation of sex and gender. Our recommendation goes beyond work specifically on TNBGNC students in STEM and to all studies that collect gender data. Trans studies scholars have discussed frameworks and methodologies to navigate gender discussions in ways that are not overly reductive and legitimize and validate the experiences of TNBGNC students. Philosophers Jacob Hale and Viviane Namaste both provide frameworks for understanding trans experience and conducting research with trans communities that avoid positioning them as an out-group (see [30], [31]). These frameworks can be utilized in STEM and engineering education studies in addition to traditional theoretical frameworks and methodologies to elevate gender discourse.

Finally, we recommend that STEM and engineering education researchers critically engage with the intersectional identities of TNBGNC individuals who belong to multiple marginalized groups. Current trans studies work has acknowledged intersectional identities as a gap in present research, where researchers should consider the experiences of individuals who face compounded marginalization due to the intersection of their gender identity with other aspects of their identity, such as race, ethnicity, disability, and socioeconomic status. By addressing their intersectional identities, we can better understand the unique challenges and resilience strategies of these TNBGNC individuals. This approach ensures that research moves beyond a generalized and monolithic understanding of the TNBGNC community by offering nuanced insights that reflect the diverse experiences within the TNBGNC community and foster more inclusive and equitable practices in engineering and STEM more broadly.

Conclusions

The findings and discussions of this study emphasize the persistent challenges faced by the TNBGNC community and how STEM and engineering education scholars conduct research, including the otherization of TNBGNC participants, reductive conflations of sex and gender, and the gap of research on intersectional identities. While TNBGNC research in STEM has been quite progressive in its incorporation of TNBGNC scholars and problematizing traditional pitfalls of gender discourse in STEM education, areas of improvement exist in the methodologies and perspectives that permeate the field. The recommendations provided underscore the need for collaborative partnerships with TNBGNC researchers, the adoption of trans-inclusive frameworks, and the critical examination of intersectional identities. By integrating these

practices, STEM and engineering education researchers can contribute work that not only avoids otherizing the TNBGNC community but actively supports their inclusion, representation, and success in STEM. This holistic approach advances both academic rigor and TNBGNC inclusion in engineering and STEM and paves the way for more meaningful and equitable research outcomes.

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