An exploration of gendered violence in engineering spaces experienced by women in Latin America

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Abstract– ***This full paper presents preliminary results from a broader research project analyzing the stories of successful Latin American women in engineering published as part of the CAL Matilda. Framed under the consideration of direct, systemic and cultural violence, we explore what expressions of gendered violence are found in the lived narratives of successful women engineers in Latin America through a qualitative inductive process. Our preliminary results showcase experiences with public discrimination, the need to prove their capabilities, dealing with gender exclusive spaces, facing jokes and insults related to gender, as well as the experience of sexual harassment. We present how this work will continue, and how its results could support the advancement of our understanding of gendered violence in engineering spaces and consequently contribute to the intentional creation of more inclusive educational spaces where women are more likely to persist and succeed in engineering.***

Keywords-- ***gendered violence, women, engineering, educational innovation, higher education.***

I. Introduction

This paper presents preliminary results from an ongoing study aimed at identifying and characterizing expressions of gendered violence in engineering education ecosystems experienced by women in Latin American contexts. The underrepresentation of women in engineering is a persisting global problem [1]. In the global north, extensive research has been devoted to characterizing the challenges that women and other gender minorities face within engineering education culture, which undermines their persistence in the field [2]. In the U.S., the "chilly climate" experienced by wom en students in engineering and other STEM fields has had an undoubtedly negative effect on women's inclination to continue their engineering education and professional practice [3]. Similarly, among women faculty in engineering, who are critical role models for future generations of women engineers , extensive empirical evidence has documented that the chilly climate continues [4], jeopardizing their persistence. These challenges lead to an enduring underrepresentation of women at all levels.

While the issues of underrepresentation of women in STEM are mirrored in Latin America and the Caribbean countries (LAC), where women's graduation rates are still far from parity [10]; in the last decades LAC countries have also gained momentum in recognizing and fighting gendered violence as a social problem [5]. In parallel, valuable efforts are taking place to advance the presence of women in engineering, such as the Cátedra Abierta Latinoamericana (CAL) Matilda [6]. Acknowledging that the male-dominated status of the engineering discipline is a socially constructed phenomenon that results in norms and values that can prevail across geographic locations, in this study, we consider the lived experiences of women engineering professionals who have shared their narratives with CAL Matilda to explore how gendered violence shaped their experiences in engineering education. This study is part of a larger investigation to characterize expressions of gendered violence experienced by women engineers throughout their engineering education and practice, which can be used to inform pedagogy, policy, and organizational change in engineering education ecosystems in Latin America. Therefore, the general research question pursued in this study is:

What expressions of gendered violence are found in the lived narratives of successful women engineers in Latin America?

II. Motivation

The data shows that while women participation in STEM in LAC countries has increased; women's advancement in comparison to men is still low [7]. This gender gap exists across multiple dimensions of professional STEM participation, including entry-level expectations, courses of study, career development, and leadership positions [8], [9]. Notably, although 40% of women in LAC countries graduate from STEM programs, their labor force participation has decreased to 30% [10]. This gap is especially noteworthy in Information and Communications Technology-related jobs, where female participation is only 22%, and the gender gap deepens in leadership positions [11].

Although up-to-date information on the gender gap in STEM in Latin América is available, the same is not true for engineering-specific data. Still, data from some specific LAC countries indicate that the engineering field is male-dominated. For example, according to data from ACIEM in Colombia, women represent between 26% and 30% of graduates from all engineering programs, with an average enrolment in engineering and technology-related programs between 2015 and 2022 of 69.3% for men and 30.7% for women [5].

The culture of engineering has been extensively described as masculine [12], which replicates the broader traits of the patriarchal social system that, in turn, can be argued to divide professions based on gender [13]. In LAC countries, such a gender divide has been extensively manifested, with men representing the majority (70.2%) of professionals in engineering and science, while women represent the majority (62.5%) of professionals and teachers in the health fields [10]. Indicating that professions that denote some elements of care (e.g. teaching, nursing) showcase a higher prevalence of women.

Inside the engineering profession, the gendered divisions of labor are also replicated [14]. For the case of more strongly male-dominated engineering programs (like mechanics, civil, electrical-electronics, and informatics), there are heteronormative gender roles that attribute the masculine traits and behaviours as superior and desirable, and femininity as subordinate [15]. In turn, this favours exercises of power that justify violence based on this kind of organization, generating unsafe environments that affect girls, adolescents, and women, leading to low performance, stagnation, and attrition, consequently configuring gender gaps as a "natural" consequence.

The classification of professions by gender impacts girls' aspirations to enter engineering programs. Heteronormative gender norms perpetuate stereotypes that are internalized during socialization and cause self-selection bias, influencing girls' decisions not to pursue STEM education, particularly, some engineering disciplines. These internalized stereotypes impose gender-based STEM expectations and roles, shaping the girls´ interests, self-confidence, and performance [7].

The causes of such gender disparities need further attention, especially in LAC countries, where larger sociocultural problems related to gender-based violence have been brought to light to be significant problems that challenge societal advancement and prosperity, and most importantly, a prevalent key violation of human rights [16]. Recognizing that persistent underrepresentation of women in STEM derives from structural inequalities, stereotypes, unequal care burdens, and lack of support systems, the Inter-American Development Bank underlines the lack of data and analytical studies to design effective policies to address gender gaps [17]. The United Nations Development Program (UNDP) states that the gender-related workplace harassment also remains an understudied issue in the STEM field in LAC, and among other actions, it is necessary to address deep-seated gender stereotypes to encourage more women to pursue STEM degrees and jobs [10]. Finally, recognizing the sociocultural factors that hinder women from entering and succeeding in STEM fields, the UN Women organization recommends applying a systematic approach to address the inequalities for women and highlights the necessity of studies that explore the sociocultural causes of these inequalities [18].

It is critical to generate a characterization of the experiences of women in engineering that could support a thorough understanding of the day-to-day barriers they face and might contribute to their stagnation, attrition, and unsuccessful development in engineering. We focus on gendered violence as a crucial barrier for women in engineering, as the central premise of this study is that the gender gap is intrinsically linked to violence, discrimination, biases, and gender stereotypes. These historical processes and dichotomous frameworks have shaped gender relations in ways that are deeply embedded in power structures. These structures continue to influence who has access to resources, services, and influential positions in society today. Consequently, this study aims to provide a comprehensive analysis of the violence that stems from these power dynamics.

III. Background

A. Conceptualizing violence

For this study, we use the definition provided by Paulson & Tikly [19] in their reconceptualization of violence within international and comparative education, which defines violence as

> *any act of power, whether directly or via systemic and cultural forms, that results in physical, psychological, emotional, environmental or spiritual harm and that has the effect of limiting the capabilities (opportunity freedoms) available to individuals, groups, other species and natural systems.*

This definition is an updated version of the widely used Galtung's model for violence [20], which recognizes the existence of three different types of violence. Direct violence refers to events that directly inflict harm and involve specific actors; structural violence, on the other hand, does not involve a person but instead as structures that distribute unequal power and result in unequal distribution of resources. Finally, cultural violence are aspects in a culture that makes the perception of structural violence feel right, or at least not wrong. Galtung's model, however, declares cultural and structural violence as invisible in comparison to direct violence. In this updated model, power is acknowledged as having a critical role in the infliction (consciously or unconsciously) or reception of such violence, and personal experience (or lack of it) is acknowledged as the visibilizing factor for all three different violences [19].

Figure 1 presents the iceberg representation, which describes the three types of violence as different types of the same iceberg, yet the line of visibilization of each will depend on each individual's experience with such violences, which in

turn depends on the power that an individual holds in a particular context or system.

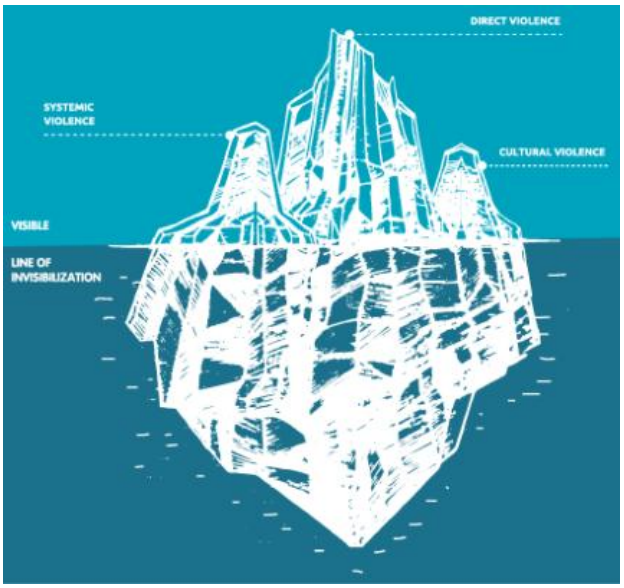

Fig. 1 Iceberg representation for the three types of violence. Source: Paulson & Tikly [19]

While this model is proposed for explaining all types of violence, we use it in the specific context of gender violence, which in the last decades has been given an increased attention, specially in the LAC context [5], [21], [22]. For which many frameworks have been implemented to study and address gender violence, including academic contexts [23], [24].

In the context of engineering, gender violence can be mapped by the three types of violence described. Direct violence was inflicted upon the fourteen women murdered at l'Ecole Polytechnique on December 6, 1989; who are now known as the victims of the Montreal Massacre and were targeted for being women, accused by the gunman of being a "bunch of feminists" [25]. Systemic violence can be argued from the lack of opportunities young girls have to experience early training in skills that will lead to interest in the field (e.g. math, science, tinkering), as well as the previously mentioned gendered division of labor endorsed in society. Finally, cultural violence refers to all experiences that perpetuate beliefs that fail to challenge the status quo of gender disparity and normalize such differences in opportunities as an issue of "preference" e.g. expressed beliefs that "girls don't like math" or that women should avoid male-dominated fields.

This theoretical framing for the study is the first contribution of our project, and the one that is highlighted in this paper, as the empirical results are very preliminary. Yet, it establishes a solid path forward for strengthening our empirical results and expanding our impact.

B. Gendered violence in engineering education in LAC

According to Torres [26], identifying the way in which gender violence is reproduced in universities becomes central when these institutions proclaim the achievement of gender equality. Consequently, she develops a theoretical reflection around the cultural, structural, and subjective components of gender inequality that allow us to identify *epistemic gender violence*, which refers to the disregard for knowledge and experiences, as well as the invisibility of women's contributions in the production of academic, scientific, and technological knowledge. This epistemic violence is a way of legitimizing oppression and social exclusion by making women invisible, infantilizing, denigrating, or slandering them in the STEM field. Emerging elements demonstrate that gender violence in universities, and especially in STEM careers, takes shape in the annulment of women as subjects with epistemic authority under an assumed status of achieved gender equity, resulting in presenting the advancement of women as a mere act of will that occurs isolated from the gender order that permeates institutions.

In LAC countries, there is an emerging but growing interest in understanding and making transparent the violence in engineering. Ortmann [27] problematizes the gender gap in engineering careers in close connection with male domination in STEM fields, where women, as dominated subjects, must accept this inequality based on the dogma of a supposedly "natural and inevitable" difference between the two positions. This domination is sustained and reproduced through symbolic violence, which employs not physical means but rather subtle forms of coercion (moral, psychological, gestural, verbal) that disqualify, deny, render invisible, and fragment women for not conforming to the norm. This violence is expressed in the realm of perception, and therefore, the study examines the perception of symbolic violence in the daily experience of women who work in engineering academic circles at two universities in Buenos Aires, Argentina. The experiences collected are analysed by applying the modalities in which symbolic violence against women is expressed in scientific discourse: When they are distinguished for their excellence, when they are dismissed for their inferiority, and when they are simply ignored or denounced as "human" based on the extension of masculinity as a parameter of universality. The author highlights and calls for the challenge of identifying and interpreting these episodes in terms of patriarchal violence in order to unravel the processes of delegitimization of violence against women in engineering.

Zapata and Mireles [28] highlight the current situation regarding gender bias and violence in Civil Engineering Schools at different Universities in 24 states in Mexico, with the participation of female and male students. Identifying sexist comments, harassment, stalking, and gender discrimination as the most recurrent situations experienced by women students, which translate into emotional, psychological, and technology-facilitated violence. Suarez et al. [29] highlight that these practices are neither isolated nor exceptional, given that they found that 65% of the students had experienced sexist comments in the classroom, while 45% had witnessed gender discrimination towards their classmates with different types of gender violence clearly identified such as psychological violence and symbolic violence, as well as its modalities (institutional, workplace, public-political violence) within the Argentinian context.

A recent wave of research in gender violence conducted by young Latin American scholars have brought invaluable insights. Guzmán Gavilanes [30] studied the *crystal walls* experienced by women in STEM careers, highlighting the masculinized environments and violent practices that women face in their training. Ramírez Alpízar [31] documented the empowerment experience of students belonging to the Rocket Girls organization, exploring their professional adaptability processes in a male-dominated context. Likewise, Muslaco Díaz [32] studied the gender stereotypes perceived by eleventh-grade adolescents in the municipality of Bello, evidencing how these social constructions influence the choice of scientific and technological careers. These investigations reflect the relevance of understanding the social and emotional dimension that conditions female participation in STEM from the early stages of professional training, but from the perspective of female students.

In relation to public policies relevant to gender in engineering in the region, the research in [33] found that gender policies with a generalist perspective have not had an impact on reducing the gender gap in engineering, and that there are practically no public policies that deepen the specific treatment (factors, naturalized violence, stereotypes, barriers, impacts) in the STEM sector, particularly for engineering where the gap is most marked; making critical to implement programs that provide financial sustainability for research, innovation, and training with a focus on naturalized violence, stereotypes, barriers, and their causes and impacts in the field of engineering.

Specifically, addressing the sociocultural factors that cause gender inequality in engineering settings, including family, work, and university environments, such as gender-based violence and discrimination, gender prejudices/biases/stereotypes and imagery, characteristics and impacts of patriarchal culture, and obstacles to the academic and professional development of women in engineering, including hegemonic masculinity. This issue lends relevance to the objective of this paper.

Finally, other studies found in the review show the growing interest in the possible dimensions of gender-based violence in STEM areas. For example, several articles have explored the intersection between gender and science, technology, engineering, and mathematics from sociological and educational perspectives. The authors in [34] presented a gender-perspective approach to the development of intelligent systems for emotion detection, highlighting the need to integrate social considerations in technological research. In [35] the authors studied students' perceptions of sexual harassment and bullying in university settings, problematizing safety and equity in access to higher education. Complementarily, the authors in [36] analysed the role of Black women in STEM in non-formal learning spaces in Brazil, highlighting the intersectional barriers that persist in these disciplines. For their part, the authors in [37] examined gender inequalities in the Argentine scientific system, while [38] proposed mentoring programs to reduce the gender gap. Together, these studies provide evidence on the multiple dimensions—social, cultural, and structural—that determine women's participation in STEM.

IV. Methods

A. Positionality

We are a collective of multilingual Latin-American and Latin* scholars, engineers, educators, and researchers whose identities span gender, sexuality, nationality, and professional experience. Our collaboration is rooted in shared commitments to equity, justice, and transformation within engineering education, particularly in Latin American contexts.

Our lived experiences—shaped by migration, gendered violence, queerness, and systemic exclusion—inform our research and our purpose. Some of us have been the only women in our engineering cohorts or workplaces for decades. Some have hidden aspects of their identities to survive in professional spaces. Others enter this work from a position of profound allyship, recognizing the parallels between the marginalization we have experienced for not conforming to hegemonic masculinity and the toxic, misogynistic climates endured by women in engineering, through a conscious act of reckoning with our positionality as male-presenting individuals who are, by default, included in the very systems we seek to critique. We have navigated masculinized engineering cultures in Colombia, Mexico, Argentina, and the United States, often finding ourselves at odds with dominant norms. Nevertheless, through these challenges, we have also found solidarity, inspiration, and a drive to reimagine engineering as a more inclusive and humane practice.

Our paths converged through shared recognition: of the violences (a term we use to encompass systemic, psychological, and professional acts of violence) that persist in engineering education ecosystems, the silences surrounding them, and the urgent need to name and challenge these realities. We are motivated by a desire to amplify the voices of those historically excluded, to interrogate the structures that perpetuate inequity, and to explore how gender, queerness, ethnicity, and culture intersect in engineering education and practice.

This research is not only academic—it is personal and political. It is a space where we reckon with our roles within systems of power and strive to contribute to a future in which no one must choose between their identity and professional aspirations. We write with the hope that our work will support the empowerment of women and gender-diverse individuals in engineering and help cultivate more just and equitable engineering ecosystems across the Americas.

B. Data corpus

Our data corpus consists of five volumes of the book series titled “Matilda y las Mujeres en Ingeniería en América Latina” loosely translates to “Matilda and Women in Engineering in Latin America.” This book series comprises a collective project motivated by *la Cátedra Abierta Latinoamericana Matilda y las Mujeres en Ingeniería (CAL-Matilda)*, whose purpose is to make visible the experiences and trajectories of successful women in STEM from various LAC

countries. Since its first publication in 2020, the collection has grown to six volumes, featuring over one hundred autobiographical and reflective stories spanning multiple generations, STEM disciplines, and sociocultural contexts. They narrate the challenges and difficulties women face in STEM fields, particularly instances in which they were marginalized, subjected to gendered violence, and exposed to biases and stereotypes characteristic of a male-focused, sexist culture. Table 1 shows each book´s distribution of narratives by country.

TABLE I
NUMBER OF NARRATIVES TO BE ANALYZED

	Book number					Total by country
Country	**1**	**2**	**3**	**4**	**5**	
Argentina	7	18	30	18	11	**84**
Bolivia	-	1	2	-	4	**7**
Brasil	-	-	-	1	-	**1**
Colombia	5	6	8	15	16	**50**
Ecuador	-	1	3	-	3	**7**
México	4	1	-	5	4	**14**
Chile	2	3	3	-	-	**8**
Costa Rica	-	6	-	-	-	**6**
Nicaragua	-	1	-	-	-	**1**
Panamá	-	1	-	-	-	**1**
Perú	1	-	-	3	-	**4**
Paraguay	1	-	-	-	-	**1**
EE.UU	1	-	-	-	-	**1**
Total by book	**21**	**38**	**46**	**42**	**38**	**185**

C. Analytical pathway

To conduct our analysis, each co-author began analysing one of the five current books. We each initially read our books to filter out which narratives, separated by book chapters, were relevant to our research question. The narratives that were not included were those that included descriptions of institutional aspects unrelated to the research question, did not include a story or episode about violence, or those that only conducted a literature review. Our initial filtration process yielded 71 chapters with relevant narratives for future analysis. As we filtered through the book chapters, we analytically memoed the narratives [25], noting repeating ideas and unique experiences we felt were relevant to discuss with the research team at our next meeting. As we initially coded the narratives, we took note of the country of origin of the author, the moment in time covered in the narrative, the STEM discipline of the author, captured overarching themes in the chapter, documented whether the chapter followed a narrative structure, and whether or not we would analyse this chapter in future analysis stages.

Once we completed our initial analytical memoing and data analysis individually, we convened virtually to discuss our initial observations from our narratives. Each author identified the topics or content that were relevant to the purpose of the study and wrote a summary of their preliminary findings. One author then collected these syntheses and performed a general analysis, identifying similar facts and situations that should be classified as initial findings, that is, expressions of violence.

As a result, this paper presents preliminary results in the form of a *high-level meta-analysis* of the inductive qualitative memos rather than a completely developed qualitative inquiry. We acknowledge this as a limitation of this paper. However, since the initial memoing took place before the selection of our theoretical framework, we also see it as an opportunity to present the high-level insights that the first approximation to the data provided.

As part of our analytical plan and according to known standards for qualitative inquiry [39] we have the goal to formally compile the list of codes used, as well as selecting specific excerpts in the selected stories to trace back our insights. We will also revise our open-coding process making sure all co-authors remain “open to the data” as we generate additional analytical memos and themes. In addition, both inductive as well as deductive approaches to coding will take place given that the described theoretical framework now has the potential to contribute to our insights. Similarly, we plan to work in calculating an interrater reliability once we have more than one coder analysing the same stories [39].

V. PRELIMINARY RESULTS

As result of a *high-level meta-analysis* of the inductive qualitative memos, this section provides brief descriptions of experiences involving stories or episodes of gender-based violence that were classified in an emergent manner. This means that they were grouped together based on their similarities. This is the first step in the analytical plan for inductive qualitative content analysis. We are actively avoiding the inclusion of excerpts in this presentation of preliminary results since we would need to present the original text in Spanish as well as their corresponding translation in English. We organize these violences according to the three dimensions of violence discussed in our theoretical framework: direct, cultural, and systemic.

A. Direct Violence

In this dimension of violence, we group events that directly inflict harm, for which specific actors can be identified as perpetrators of it. Sexual harassment, insults, and challenges to their capabilities and femininity are all included in this category:

Sexual harassment. These were the most blatant instances showcasing direct violence towards women in the narratives. When they described sexual harassment taking place, these situations forced women to focus on defending themselves, as they didn´t have external support. This frequently caused low performance while studying or working as engineers.

Insulting gendered jokes, taunts, and tagging. Women´s social skills and capabilities were insulted by their classmates of coworkers. They were judged as "complicated" for teamwork or "brutas" (less intelligent than men). Some male colleagues were surprised when women proved to be as intelligent as them, or even more so.

Contempt for their physical appearance. Some women in our pool of narratives described being scorned for not meeting imagined, heteronormative physical standards.

Proving their capabilities. Women were required to prove their capabilities simply because of their gender. Men were not subjected to the same demands. In some cases, women were

accused of having affairs with their bosses as the only explanation for their work position. As a natural consequence, women underestimate their capabilities and men overestimate theirs.

B. Structural Violence

As discussed, structural violence involves the unequal distribution of resources and consequently of power. Public discrimination, aspects that made physical workspaces unwelcoming for women, the "Matilda" effect, and barriers derived from maternity were discussed:

Public discriminations. In this kind of discrimination, misnamed "special" places for women were created, where they had publicly to demonstrate their skills and knowledge, exposing them to the criticism of others. Examples of this include the allocation of physical space in classrooms where women should be more near to the blackboard. These instances of discrimination contrast with situations in which women were overlooked by their male teachers, peers, or colleagues.

Work implements and spaces made specifically only for men. The absence of bathrooms for women is a "classical" situation that women had to face in their workplaces.

"Matilda" effect. Some women narrate that their achievements were overlooked, downplayed, or credited to men (sometimes by themselves), despite their original contributions.

Maternity as an impediment to work. After having children, women were required to prove that they were still capable of doing their jobs as well as they did before becoming mothers.

C. Cultural Violence

Finally, cultural violence are aspects in a culture that makes the perception of structural violence feel right, or at least not wrong. In this dimension, gender-based stereotypes and conflicts with other women were highlighted:

Gender-Based Stereotypes. These include statements such as "engineering is not for women" or "it is too difficult for women," as well as preventing women from entering the field. This applies to engineering studies and work. Some men have insulted women by stating that they can only perform housework tasks in the workplace, such as cooking or serving coffee to men. Stereotypes are part of a set of gendered violences expressed as sexism, or machismo in Spanish. The glass ceiling is one of the most common forms of sexism in workplaces.

Women conflicts. Sometimes women themselves get competitive and fight with one another and try to take the other down. In these cases, women perpetuate violences against each other due to competition, failure to support one another based on gender. This perpetuated violence occurs from women in authority positions against other women, or from women in a higher social status.

Besides the diversity of violence found, we highlight other emerging findings contained in narratives:

Hopes for the future. Wishes and words of wisdom from women who have made it through challenging situations in engineering.

Differing levels of support from vocal family (dads and moms) that support their female engineering student daughters. Sometimes family wonders why do you want to study this masculine field? Some families acknowledge the masculinity in the field and don't want their daughters to go through that, so they acknowledge this fact and support their daughters. The daughter had to contend with this tension. *Orgullo* that comes from balancing social expectations of what it means to be a woman (having/making a family) and being a successful professional engineer. As a result, the emotional scars are battle wounds with dual value, representing a source of pain as well as strength for having overcome them.

VI. Conclusions And Future Work

The results presented show the current state of a larger research project with two main methodological branches, which both contribute to the larger project's main objective of describing gendered violences experienced by Latin American women in engineering. We presented a theoretical organization of the instances of violence identified through the high-level meta-analysis of the first qualitative results. Through such organization, we find that the use of Galtung's modified model presented by Paulson & Tikly [19] shows to be promising to identify and classify the variety of violences faced by women in engineering in LAC.

Through the more thorough execution of the qualitative inquiry planned by this project, and presented in our analytical approach, we will generate an iterative construction of richer emergent categories that, in dialogue with existing theories on gender-based violence. Such insights will facilitate the development of a taxonomy to characterize gender-based violence in engineering environments.

In the second methodological branch of this work, we will also expand this inquiry in the analysis of the identified corpus using automatic analysis techniques to validate and contextualize the expert-driven taxonomy. Text-mining and NLP routines are planned to be employed, together with semi-automatic keyword searches, whose outputs will be systematically reviewed and verified by the research team [40], [41]. This complementary dimension is conceived to generate descriptive and visual evidence that enhances the interpretive depth of the qualitative analysis, while preserving the central role of expert-driven coding and theoretical grounding as the study's core [42], [43].

All applications of NLP and semi-automatic routines are designed to remain fully transparent, with systematic documentation of scripts and prompts, in order to ensure reproducibility and methodological rigor [44]. Future incorporation of advanced NLP and machine learning techniques is envisioned to extend the scope of the analysis and explore new dimensions in the study of gender narratives in STEM [45].

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