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# Gender Dynamics in STEM Education: Students and Pre-Service Teachers' Voices

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**Abstract:** Building on previous research on ICT and gender, this paper explores the interrelations between gender and STEM in educational contexts in Portugal. The research aims to improve the understanding of the co-production of gender and STEM careers and to develop strategies to promote gender equity in STEM. The methodology was based on a structured workshop divided into five phases (representations, facts analysis, causes and impacts, attitudes, and strategies), each designed to address a critical aspect of the intersection of gender and STEM. Aligned with an advocacy/participatory framework, this methodology empowers participants to actively engage in the dialogue on gender equity in STEM and take meaningful actions toward fostering more inclusive environments. The study involved two distinct populations: pre-service elementary school teachers from a higher education institution and ninth-grade students. This selection was based on prior research emphasizing the influence of elementary teachers' attitudes toward gender and STEM careers on students' educational choices, which are made at the end of ninth grade in the Portuguese education system. The results indicated differences in the representations and attitudes of ninth-grade students and pre-service teachers regarding the gender gap in STEM, as well as variations in how girls and boys perceive and approach this issue.



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**Keywords:** gender gap; STEM; Portugal; education; structured workshop

## 1. Introduction

In recent years, the topic of gender representation in STEM (Science, Technology, Engineering, and Mathematics) has gained increasing importance, and investigating this issue is particularly relevant in contemporary educational and professional landscapes (Evagorou et al. 2024). In Portugal, as in many other countries, the presence and portrayal of gender within STEM fields reveal both progress and persistent challenges (CIG 2024; Monteiro and Lopes 2022). Understanding these dynamics is crucial, as STEM-related skills are integral to innovation, economic development, and addressing some of the world's most pressing issues, from climate change to health crises (European Institute for Gender Equality 2017).

The gender gap in STEM has profound implications, both for individuals and for society. For individual women, limited representation can mean fewer role models and a lack of mentoring, which are critical to navigating male-dominated fields (Makarova et al. 2019). For society, a lack of gender diversity in STEM limits the breadth of perspectives

and ideas, which can stymie innovation and lead to products and policies that do not fully serve the needs of a diverse population (European Institute for Gender Equality 2017).

The importance of studying gender representation in STEM, particularly in Portugal, cannot be overstated. This issue intersects with broader themes of social equity, economic development, and innovation. By addressing gender disparities, challenging stereotypes, promoting female role models, and implementing supportive policies, Portugal can create a more inclusive and diverse STEM landscape (Felgueira et al. 2024). This is not only a matter of justice but also a strategic investment in the nation's future, ensuring that the talents of all citizens contribute to advancements in science, technology, engineering, and mathematics (Monteiro and Lopes 2022).

Building on previous research on ICT and gender, this paper (Ferreira 2017; Ferreira and Silva 2016, 2023) will further explore the interrelations between gender and STEM in educational contexts in Portugal. Fostering gender equity in STEM, the global aim of this research is to improve the understanding of the co-production of gender and STEM careers. Specifically, this research aims to (i) explore the interrelations between gender stereotypes and educational choices and (ii) explore methods and tools for integrating a gender perspective in STEM education.

To address the views of diverse actors of the gender and STEM Portuguese landscape, the study involved two distinct types of participants: pre-service elementary school teachers from a higher education institution and ninth-grade students.

Participants' gender identity in this research was determined by self-identification, and there were only identifications as either a girl or a boy. Therefore, the results are presented and analyzed using a binary approach. This choice is not intended to reinforce gender binary norms but to provide a starting point for discussions that can evolve toward greater inclusion and awareness. We critically examine and challenge the binary conception of gender as a social construct, recognizing that gender identity exists on a diverse spectrum and often transcends the conventional categories of "girls" and "boys" (Butler 2024). This awareness is central to our theoretical framework, which aims to foster inclusivity and an understanding of diversity. We remain committed to questioning and challenging restrictive norms, acknowledging the complexity of gender. This is an evolving process, and we remain open to learning, adapting, and incorporating broader, more inclusive frameworks as part of our ongoing journey.

This introduction sets the stage for the subsequent sections of the paper, including a theoretical background, the presentation of the methods and techniques used, the study's results, and the discussion of those findings, leading to the final conclusions. The last section (Section 6) contains the bibliographic references.

## 2. Theoretical Perspectives on Gender and STEM: Overcoming Stereotypes and Promoting Inclusion

Stereotypes about gender and STEM proficiency remain pervasive and can significantly influence both educational outcomes and professional opportunities (Master and Meltzoff 2020; Ferreira 2017). Societal expectations about who is 'naturally' inclined toward certain subjects create invisible barriers that dissuade women from entering or excelling in STEM (Miller et al. 2018). Overcoming these stereotypes is key to fostering gender equity in STEM. Research has shown that when girls and young women are encouraged to see STEM as accessible and relevant to their lives, they are more likely to pursue it (Jungert et al. 2019). Therefore, dismantling stereotypes is crucial in creating an educational environment that supports and encourages diversity.

### 2.1. Challenging Gender Bias in STEM

STEM fields have long been constructed as objective and neutral, yet they are embedded with androcentric biases that shape research agendas, institutional practices, and professional hierarchies. The underrepresentation of women in STEM is not merely a matter of individual choice but reflects systemic exclusions that devalue women's intellectual contributions (Harding 1991). By applying feminist epistemology, we challenge the notion that STEM proficiency is inherently gendered. The stereotype that men are naturally more adept at mathematics and science reinforces a knowledge hierarchy that marginalizes women and non-binary individuals (Allegrini 2015). This epistemic injustice discourages female participation in STEM and perpetuates male dominance in technical and scientific fields.

An intersectional approach (Crenshaw et al. 2021) reveals that the gender gap in STEM is not experienced uniformly across different social groups. Women of color, working-class women, LGBTQ+ individuals, and women with disabilities face compounded barriers due to the intersection of gender discrimination with racism, classism, ableism, and heteronormativity (Campbell 2020). For instance, while Portugal has implemented initiatives to support gender equality in STEM, these programs often fail to address how race, socioeconomic background, and disability further limit access (Alonso 2010). Addressing the gender gap requires policies that acknowledge and dismantle these overlapping forms of oppression rather than adopting a one-size-fits-all approach.

Critical pedagogy, as proposed by Freire (Freire and Macedo 2014), provides a powerful framework for transforming STEM education by addressing systemic inequalities. Instead of encouraging passive acceptance of existing structures, this approach empowers students to critically engage with and challenge oppressive systems. One key strategy involves decolonizing STEM curricula by incorporating diverse perspectives and recognizing the contributions of women and marginalized communities in science and technology. Gender-sensitive teaching methodologies play a crucial role, fostering collaborative learning, active participation, and critical engagement with gender biases in STEM (White et al. 2021; Monteiro et al. 2024). Additionally, mentorship and representation are essential, with programs that connect young women to female STEM professionals, offering guidance and role models. Another critical aspect is the need to challenge assessment biases by redesigning evaluation methods to ensure equitable recognition of skills and knowledge beyond traditional, male-centered measures of success (Babaci-Wilhite 2022). Beyond individual empowerment, systemic reforms are necessary to drive structural change. Governments, academic institutions, and industries must take responsibility for implementing gender-equitable hiring and promotion policies in STEM fields. Research funding should be directed toward examining the impact of gender biases in both STEM education and professional environments. Moreover, the creation of inclusive workspaces is vital, addressing issues such as wage gaps, work-life balance, and discrimination. Only through these combined efforts can STEM education and professional fields become truly equitable and inclusive.

### 2.2. Breaking Barriers

Barriers to gender equality in STEM can be categorized into structural, cultural, and individual barriers. Structural barriers involve institutional policies, such as hiring practices and career support systems, that contribute to gender inequities across STEM fields. Cultural barriers arise from entrenched gender stereotypes and biases that shape educational environments and societal expectations concerning STEM roles. Individual barriers include personal perceptions, lack of role models, and diminished self-efficacy that limit women's pursuit of STEM careers (Verdugo-Castro et al. 2022).

Individual barriers encompass personal perceptions and internalized stereotypes that women may experience, significantly impacting their academic choices. A recent report from NESET, European Commission's advisory network of experts working on the social dimension of education and training (Evagorou et al. 2024), underscores a persistent challenge in STEM education: while girls often perform as well as or better than boys academically in these subjects, they tend to exhibit lower self-confidence. This disparity in self-efficacy significantly impacts their willingness to pursue STEM fields further, highlighting the critical role that confidence plays in shaping career aspirations (Chan 2022; Ferreira and Silva 2023).

Social norms continue to perpetuate traditional gender roles, significantly affecting women's engagement in STEM. The influence of family and broader societal contexts emerges as a key factor in guiding girls' decisions about STEM education and careers (Šimunović and Babarović 2020). Early exposure to STEM, combined with supportive environments and the dismantling of societal stereotypes, proves essential in fostering and maintaining their interest in these fields (Master 2021).

Structural barriers, including institutional cultures, complicate the advancement of women in STEM. Systemic barriers within educational institutions exacerbate the gender gap. Non-inclusive curricula, teaching practices that reinforce stereotypes, and the lack of visible female role models in STEM contribute to the underrepresentation of girls (Stoet and Geary 2018; Siani et al. 2022). To address these issues, the aforementioned report (Evagorou et al. 2024) advocates for the adoption of gender-sensitive teaching strategies and the integration of STEM subjects in a way that actively promotes inclusion and engagement, paving the way for greater female participation in STEM disciplines.

### 2.3. STEM Gender Gap in Portugal: Challenges and Initiatives

In Portugal, as in many countries, the gender gap in STEM is evident in both educational and professional arenas. Studies reveal that while women have made strides in many academic disciplines, they remain underrepresented in STEM fields, particularly in engineering, technology, and certain scientific domains (Monteiro and Lopes 2022). Progress is uneven, with some fields like healthcare and biological sciences achieving more gender equity, while others, particularly engineering and information technology, remain male-dominated (CIG 2024). In Portuguese universities, female students are outnumbered by males in degrees like computer science and engineering, though they are more represented in fields such as biology and healthcare (CIG 2024). Information and communication technologies, essential in all sectors of the economy, represent a field where women are underrepresented; out of every 10 graduates in these areas, approximately eight are men and only about two are women (CIG 2024). This pattern mirrors international trends, where the 'leaky pipeline' phenomenon sees women gradually leave the STEM pathway due to multiple, often interrelated factors, including cultural expectations, lack of female role models, and gender-biased institutional practices (Greska 2023; Almukhambetova et al. 2023). Additionally, the persistent gender gap in STEM fields and the wage disparity highlight systemic barriers, with women often underrepresented in high-paying roles and earning significantly less than their male counterparts for equal work (Zajac et al. 2025).

Educational interventions play a crucial role in addressing and reducing gender disparities in STEM fields, starting from early education and continuing through all levels of learning. Early exposure to science and math is vital, as research indicates that engaging and interesting activities tailored for young girls can help dismantle stereotypes that portray STEM as male-dominated or unfeminine (Stephenson et al. 2022). Hands-on activities, storytelling, and exposure to relatable role models are effective in sparking interest in these fields (Akhigbe and Adeyemi 2020). Mentorship programs also prove

essential, as they connect female students with women professionals in STEM who provide guidance, networking opportunities, and inspiration, helping to foster a sense of belonging in these careers (Evagorou et al. 2024). Additionally, gender-inclusive teaching practices, where educators actively counteract biases and offer equal encouragement and feedback to boys and girls, create supportive classroom environments that bolster girls' confidence in their abilities (LaForce et al. 2019). Beyond the classroom, initiatives like STEM clubs, competitions, and science fairs, especially those designed for girls, provide alternative spaces for skill development and confidence building without the social pressures that may arise in mixed-gender settings (Schiefer et al. 2021; Lock et al. 2019). Informational sessions and parent–teacher programs can raise awareness of how biases and lack of encouragement may influence girls' interest and confidence in STEM subjects, ultimately fostering gender equity in these fields (Nalipay et al. 2021). Parental engagement is key, as educating parents about their role in encouraging their daughters in STEM can help create a supportive home environment (Cui et al. 2021).

Portugal has implemented various initiatives aimed at promoting gender equality in STEM. These programs operate at different levels, targeting both students and professionals:

- Engenheiras por Um Dia (“Engineers for a Day”) (“Engenheiras Por Um Dia” n.d.): Launched by the Portuguese government, this program is a collaborative project involving schools, universities, and companies. It aims to encourage girls from basic and secondary education to pursue careers in engineering and technology through workshops, mentorship, and project-based learning. The initiative collaborates with companies and organizations to provide girls with real-world exposure to engineering fields.
- Programa INCoDe.2030 (“Programa INCoDe.2030” 2024): Part of Portugal’s National Digital Competence Initiative, this program emphasizes gender equality in digital skills and competencies. It provides opportunities for underrepresented groups, including girls and women, to develop coding, programming, and other tech-related skills. INCoDe.2030 aims to foster digital literacy, advance inclusion, and promote specialization in fields like cybersecurity and artificial intelligence.
- Women in Tech Portugal (“Women in Tech Portugal” n.d.): Though not exclusively a government initiative, it is a notable community-driven initiative that provides support for women in technology fields through networking events, workshops, and mentorship programs. While this program mainly supports women who are already in the workforce, it also collaborates with educational institutions to offer mentoring for students interested in tech fields.
- As Raparigas do Código (Girls Who Code) (“As Raparigas Do Código” n.d.): This is a youth-focused community dedicated to promoting digital inclusion by teaching programming to school-aged girls from primary to higher education. The goal is to demystify the role of women in technology and encourage more girls to pursue careers in the information technology sector.
- Ciência Viva (“Living Science”) (“Ciência Viva” n.d.): This is a broader initiative that promotes science literacy and STEM education in Portugal. With programs specifically designed for young students, Ciência Viva offers summer internships and science education programs that encourage participation from girls and boys alike. Although it does not focus exclusively on gender equity, it has become an important avenue for girls to gain exposure to scientific fields.

Portugal’s efforts toward gender equity in STEM highlight the country’s commitment to building a more inclusive scientific and technological workforce. However, there is a need for more multi-faceted approaches to closing the gender gap, with the support of policymakers and tailored educational programs, addressing barriers from early education through professional development. A national program to promote women’s participation

in technology will be introduced in early 2025, integrated into the National Digital Strategy approved by the Council of Ministers on 12 December 2024 (“[Comunicado do Conselho de Ministros de 12 de dezembro de 2024](#)” n.d.). It will focus on the areas of education, higher education, and the labor market, aiming to foster girls’ interest in STEM. As part of the program, new initiatives will be created, and existing actions will be considered to ensure they are implemented under an integrated guiding framework with common objectives, result indicators, and targets.

The gender gap in STEM is not simply an issue of representation but a reflection of deeply entrenched power dynamics. Addressing it requires a transformative approach that combines feminist epistemology, intersectionality, and critical pedagogy. By challenging dominant narratives, restructuring educational practices, and implementing systemic reforms, we can move toward a more inclusive and just STEM landscape.

### 3. Materials and Methods

#### 3.1. Framing Research Design

This section presents the methodological rationale for using a structured workshop to improve the understanding of the co-production of gender and STEM careers, analyze the relationship between gender stereotypes and educational choices, and explore pedagogical approaches for integrating a gender perspective into STEM education. Based on participatory learning theories ([Berthelsen 2008](#)) and qualitative research principles ([Creswell 2014](#)), this research aims to explore the interrelations between gender stereotypes and educational choices, and to explore pedagogical methods and tools for integrating a gender perspective in STEM education. Grounded in critical pedagogy ([Kincheloe et al. 2017](#)), feminist epistemology ([Ashton and McKenna 2020](#)), and intersectionality ([Misra et al. 2024](#)), this workshop aims to encourage participants to engage critically with the topic through activities designed to foster both individual reflection and collective discussion. Additionally, the approach should allow a deep exploration of complex social issues, such as gender dynamics in STEM, by focusing on participants’ experiences and perspectives through qualitative inquiry.

This participatory method resonates with the concept of reflexivity, a key aspect of feminist research methodology ([Alvesson and Sköldbberg 2009](#)). Reflexivity encourages researchers to critically reflect on their own positionality and how it influences the research process. Through dialogue and reflection in workshops, researchers can gain a deeper understanding of participants’ lived experiences, enriching the analysis of how gendered experiences shape engagement in STEM.

#### 3.2. Structured Workshop as a Method

The research design of this study, and its workshop, is grounded in social constructivism, where meaning is co-constructed by participants as they engage with the proposed activities ([Creswell 2014](#)). This approach aligns with the workshop aims, which include encouraging participants to reflect on their lived experiences and collectively explore the social constructs of gender in STEM fields. Qualitative research often seeks to understand the meanings that participants attribute to their experiences, which is essential when examining deeply ingrained stereotypes and biases in STEM ([Creswell 2014](#)). Following the principle of open-ended inquiry, where participants construct knowledge through social interaction, the workshop will be structured around phases of critical reflection, data analysis, and strategic planning. Additionally, the advocacy/participatory approach supports this method by not only exploring participants’ views but also empowering them to promote change, particularly in advancing gender equity in STEM fields ([Creswell and Guetterman 2019](#)).

Key elements of qualitative research design—knowledge claims, strategies of inquiry, and methods—are deeply integrated into the structure of the workshop. Participants' personal experiences, perspectives, and interactions are central to shaping the study's outcomes, emphasizing that knowledge is socially constructed and context-dependent (Creswell and Guetterman 2019).

The inquiry strategy is both interactive and participatory, focusing not only on understanding gender issues in STEM, but also on empowering participants to enact meaningful change. Through collaborative discussions, data analysis, and the development of actionable strategies, participants are encouraged to engage actively and critically with the material, moving beyond reflection to consider how they can contribute to solutions.

The methods used in the workshop are primarily open-ended and qualitative, encouraging participants to share their reflections and engage in in-depth discussions. The researcher facilitates these conversations, guiding participants through each phase of the workshop. Workshop data collection methods allow complex issues to be explored in a way that provides rich, detailed insights into participants' experiences and perspectives. This type of data is crucial when studying the social dimensions of gender in STEM, where quantitative metrics often fall short in capturing the full complexity of lived experiences.

### 3.3. Workshop Design and Implementation

#### 3.3.1. Workshop Design

The workshop is divided into five phases, each designed to address a critical aspect of the intersection of gender and STEM (Figure 1). Each workshop's phase has specific guiding questions (Table 1).

**Table 1.** Description of the workshop's phases.

Phase	Description	Guiding Questions
Phase 1: Representations	This phase involves exploring cultural narratives and stereotypes about gender roles in STEM. Participants are invited to reflect on the images and messages they have encountered throughout their lives. This phase encourages participants to critically assess how these representations have shaped their understanding of gender in STEM. This reflection is vital for identifying unconscious biases and setting the stage for more in-depth discussions.	<ul style="list-style-type: none"> <li>• Are there gender differences in the professional fields of science and mathematics? If so, what are they?</li> <li>• Are there gender differences in the professional fields of engineering and technology? If so, what are they?</li> <li>• What are your thoughts on the relationship between gender and STEM fields?</li> </ul>
Phase 2: Facts Analysis	Participants engage with statistical data (shared by the researcher) to analyze gender disparities in STEM, providing a factual basis for understanding the scope and scale of the issue. Grounding discussions in empirical evidence helps dispel myths and misconceptions, ensuring that further dialogue is rooted in facts and is contextually relevant to participants.	<p>Based on the statistical data of Portugal provided, answer the following questions:</p> <ul style="list-style-type: none"> <li>• How would you describe the gender differences in the professional fields of science and mathematics, and in engineering and technology?</li> <li>• Do these findings align with your initial expectations?</li> <li>• Are there any differences? If so, what are they?</li> </ul>

Table 1. Cont.

Phase	Description	Guiding Questions
Phase 3: Causes and Impacts	In this phase, participants explore the broader social and individual causes and impacts of gender disparities in STEM. The workshop fosters reflection on how these disparities affect innovation, economic growth, and diversity, promoting a deeper understanding of systemic gender inequities.	<ul style="list-style-type: none"> <li>• What are the possible causes of gender differences in the professional fields of science and mathematics, and of engineering and technology?</li> <li>• What are the impacts on individual choices and personal/professional fulfillment?</li> <li>• Are there impacts on society? If so, what are they?</li> </ul>
Phase 4: Attitudes	This phase involves a critical examination of personal and societal attitudes toward gender roles in STEM, encouraging self-examination and peer learning, helping participants recognize and confront their biases. Participants reflect on their own beliefs as well as societal norms that perpetuate gender disparities. By critically assessing these attitudes, participants can foster a more informed and conscious perspective on gender in STEM.	<ul style="list-style-type: none"> <li>• Do you think it is important and/or necessary to change this situation?</li> <li>• Why?</li> </ul>
Phase 5: Strategies	The final phase focuses on generating strategies for addressing gender disparities in STEM. Participants are empowered to think creatively and collaboratively about potential solutions, and the workshop concludes with actionable strategies. This phase encourages participants to consider their roles as advocates for gender equity, both within their immediate environments and in the broader societal context.	<ul style="list-style-type: none"> <li>• For 9th-grade students: As students who must choose an educational path, what kind of initiatives can be developed in education in Portugal to promote gender equality in the professional fields of science and mathematics, as well as engineering and technology?</li> <li>• For pre-service elementary school teachers: As future teachers, what initiatives can be developed in education in Portugal to promote gender equality in the professional fields of science and mathematics, as well as engineering and technology?</li> <li>• Do you know of any initiatives that promote gender equality in the professional fields of science and mathematics, as well as engineering and technology? Which ones?</li> </ul>

Taking into account the differences in the gender gap between the fields of science and mathematics, and engineering and technology (Fernandes et al. 2023), the questions were specifically tailored for each area. The guiding questions were conversations starters, the interaction with the groups followed the ideas presented by the participants. Each phase of the workshop (about 15 to 20 min each) builds upon the others, moving from the identification of gendered representations to the generation of actionable strategies, ensuring that participants leave with both a deeper understanding of the issues and practical tools for enacting change.

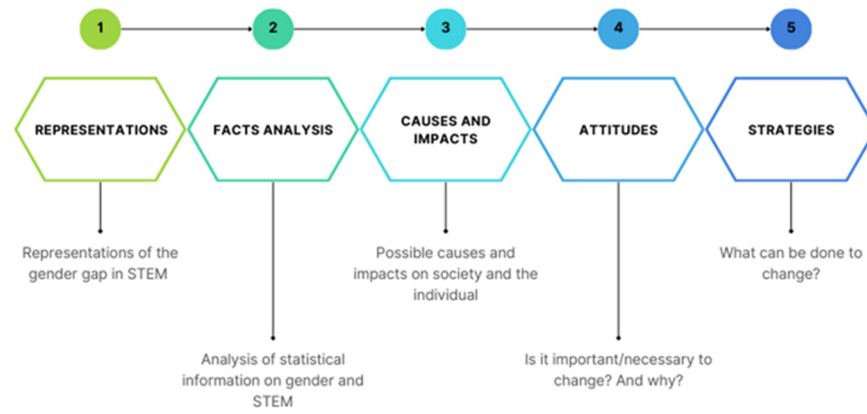


Figure 1. Phases of the structured workshop.

3.3.2. Statistical Data

The statistical information provided in ‘Phase 2: Facts Analysis’ (Figures 2–5) is based on Gender Equality in Portugal: Statistical Bulletin 2023 (Fernandes et al. 2023), published by the Commission for Citizenship and Gender Equality. In November 2024, a new statistical bulletin was published (CIG 2024); however, the fieldwork had been conducted earlier.

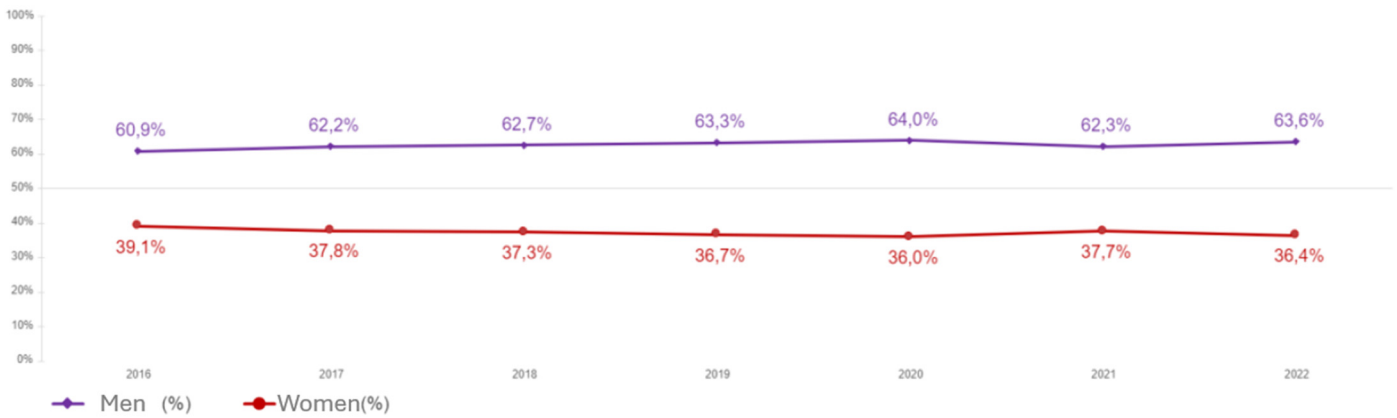


Figure 2. Evolution of graduates in STEM areas, by gender, 2016–2022 (%) (Fernandes et al. 2023).

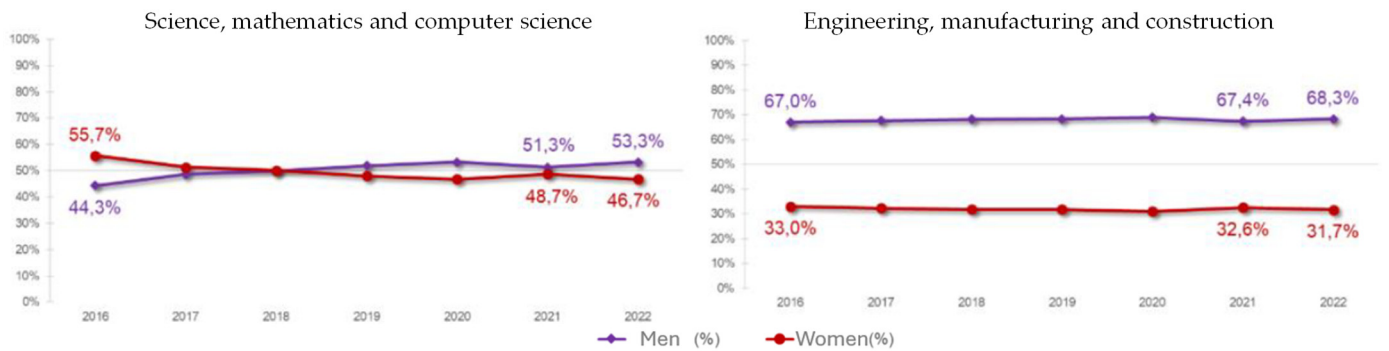
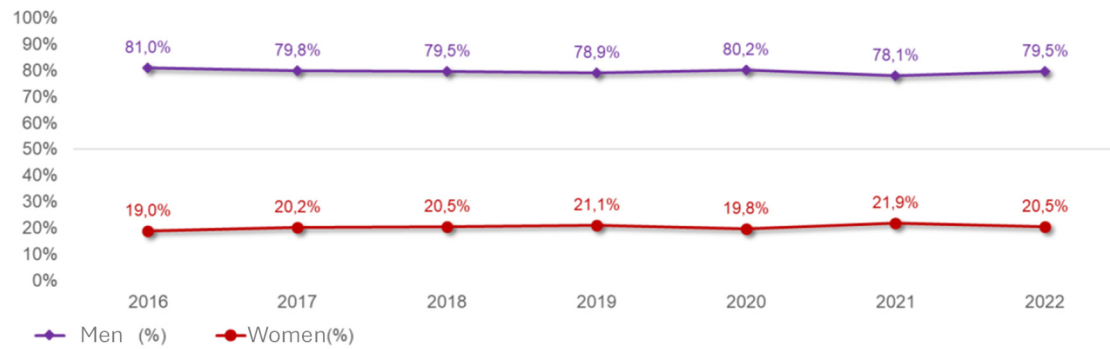
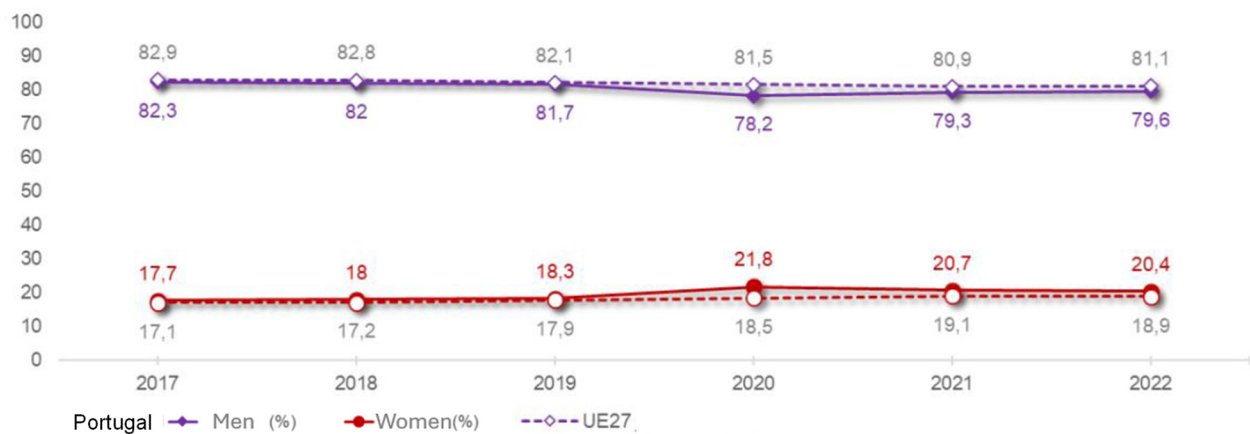


Figure 3. Evolution of graduates in subgroups “Science, mathematics and computer science” and “Engineering, manufacturing and construction”, by gender, 2016–2022 (%) (Fernandes et al. 2023).



**Figure 4.** Evolution of the proportion of female and male ICT graduates in higher education, 2016–2022 (%) (Fernandes et al. 2023).



**Figure 5.** Evolution of ICT specialists in the EU27 average and Portugal, from 2017 to 2022 (%) (Fernandes et al. 2023).

### 3.3.3. Participants Selection

The Portuguese education system is structured into multiple levels, guaranteeing universal access to education from early childhood through secondary education. Compulsory education in Portugal consists of three main stages: preschool (for children under six), basic education (a nine-year program divided into three cycles), and secondary education (a three-year program). Upon completing basic education in the 9th grade, students must choose a specific area of study to pursue secondary education, shaping their academic and professional pathways.

For the workshop on gender and STEM, participants were selected based on their educational stage and potential influence on future STEM pathways. Two primary groups were targeted:

- 9th-grade students—they are at a critical decision-making stage in their education. At this level, students in Portugal complete the basic education and must choose one area of study: science and technology, socioeconomic sciences, languages and humanities, visual arts, or a professional program. Identifying their ideas about gender and STEM can help highlight any early biases or barriers that may affect educational and career choices. Understanding these perceptions allows the workshop to address stereotypes that might dissuade students, particularly girls, from pursuing STEM-related studies. Engaging them in this workshop provides an early opportunity to address potential gender biases and promote an inclusive view of STEM fields, supporting more informed and diverse educational choices.
- Pre-service elementary school teachers—Their involvement is crucial because, as future educators, they will play a significant role in shaping young minds and attitudes

toward STEM fields. By understanding their current viewpoints, the workshop can allow them to identify specific areas where they might unconsciously reinforce gender stereotypes or inadvertently discourage diverse participation in STEM. Engaging them in discussions on gender in STEM provides an opportunity to develop the knowledge and resources needed to foster and support inclusive student engagement and motivation in these fields.

Ninth-grade students were from Sebastião da Gama School Group, located in Setúbal, Portugal. It is a public educational institution that serves a wide range of students, from preschool through secondary education. The group includes several schools, with Sebastião da Gama Secondary School as its central hub, along with other primary and middle schools throughout Setúbal. Together, these schools provide comprehensive education options, from foundational learning in primary grades to specialized paths in secondary education. At the secondary level, students can pursue various academic tracks, including science and technology, socioeconomic sciences, languages and humanities, and visual arts, as well as professional programs like commerce, electrotechnics, IT equipment management, and systems programming. The school group also offers evening courses for adult learners, providing opportunities for certification in both basic and secondary education and professional qualifications, such as administrative, commercial, and logistics technician.

Pre-service elementary school teachers were from Lisbon School of Education, Polytechnic University of Lisbon (ESELx), a public institution dedicated to teaching, research, and community service in education and social and cultural intervention. ESELx offers a range of undergraduate and master's programs, including degrees in Basic Education, Visual Arts and Technologies, Sociocultural Animation, and Community Music. ESELx collaborates with national and international entities on educational projects and offers various training initiatives for teachers and educators in response to institutional requests.

### 3.3.4. Field Work and Participants Characterization

The fieldwork was conducted from 30 October to 15 November.

The workshops with 9th-grade students were conducted with one group of 6 students at a time, and audio recorded. The groups were intentionally organized: 2 groups with only girls, 2 groups with only boys, and 2 mixed groups, in a total of 36 students (Table 2).

**Table 2.** 9th-grade students' characterization.

Gender	Age (Years Old)					Total
	13	14	15	16	17	
Girl	1	14	2	0	1	18
Boy	1	14	3	0	0	18

The workshops with pre-service elementary school teachers were conducted in the classroom with the whole class divided into groups of 3 to 4 students, and each group registered their ideas on paper. Most of the pre-service elementary school teachers in Portugal are girls, and as such all 23 workshop's participants were girls (Table 3).

**Table 3.** Pre-service elementary school teachers' characterization.

Gender	Age (Years Old)					Total
	21	22	23	25	>25	
Girl	6	6	3	5	3	23

To identify the participants' gender there was a question: How do you identify? (Girl, Boy, Don't know, Prefer not to say). All participants identified either as a boy or a girl.

### 3.4. Data Analysis

The data from the workshops were analyzed using thematic analysis (Braun and Clarke 2012), aiming to identify and analyze patterns or themes within a set of textual data. The 9th-grade students' recordings of the workshops were transcribed before being analyzed. The process began with an in-depth familiarization with the data, where the researchers read and re-read all the data to gain a general understanding. During this initial reading, reflective notes were made to capture recurring or significant elements. The researchers then proceeded to initial coding, breaking down the text into smaller segments and assigning codes that summarize or capture the essence of the content. These codes were based on research questions and emerged from the data itself. After coding, the researchers grouped similar codes into broader categories to identify emerging patterns and themes. This stage involved exploring connections and relationships between the codes to find themes that may address the research questions. A visual map of the themes was used to facilitate the visualization and organization of identified patterns. With preliminary themes identified, the next step was to review and refine them, going back to the data to ensure that the themes truly reflect the content and meanings present and that they are coherent and distinct. Subsequently, each theme was defined and clearly named, with detailed descriptions explaining its scope and relevance to the research. The researchers then built a thematic narrative that integrated all identified themes, explaining how they connect and contribute to answering the research questions. Examples from the data, such as participant quotes, were used to illustrate and support the identified themes. The final phase involved interpreting the themes, relating them to existing literature, and discussing their implications.

### 3.5. Ethical Considerations

The ethical commitment outlined for this study involved several safeguards to ensure transparency, data protection, and respect for participants' autonomy, and received approval from the NOVA FCSH Ethics Committee (CE-NOVA\_FCSH\_2024/86) on 28 October 2024.

The research team obtained informed consent from the legal guardians of 9th-grade students as they are minors, and from all workshops' participants. This consent included detailed information about the study and highlighted the voluntary nature of participation, the freedom to withdraw at any time without penalty, and the right to access, correct, or delete provided data. The collected personal data were pseudonymized and accessible exclusively to the research team. Data collection in the workshops, which included audio recordings, was stored on password-protected devices with no internet connection, thus ensuring an additional level of security and confidentiality. The consent form also stated that the data would be used exclusively for scientific purposes and shared in a manner that ensures participants' anonymity is preserved. The data may also be made available for future academic research, always safeguarding privacy and the right to consult or remove data.

## 4. Results

All participants, whether ninth-grade students or pre-service teachers, actively engaged in the workshops and shared their ideas. As detailed in the materials and methods, participants were asked the question, "How do you identify?" (Girl, Boy, Don't know, Prefer not to say) to determine their gender identity. Interestingly, the all-boys groups responded

differently from other groups, often giggling and joking about the question. This reaction becomes more understandable when examining their contributions during the workshops, which shed light on the social pressures boys face in relation to male stereotypes.

#### 4.1. Phase 1 Representations

##### 4.1.1. Ninth-Grade Students

The thematic analysis of the conclusions from the mixed group, girls, and boys on the questions about gender differences in STEM areas reveals notable patterns and nuances. These responses uncover shared perspectives across groups and distinct viewpoints shaped by social and cultural contexts.

- **Gender differences in sciences and mathematics:** All groups recognized that these are male-dominated fields, but with significant female representation in educational roles, such as teaching sciences and mathematics. Intellectual abilities are recognized as equally attainable by men and women. However, differences emerge in how these observations are framed. The mixed group based their opinions on personal experiences. The girls' group emphasized the impact of societal norms, while the boys' group focused more on gender equality in abilities, with less attention to cultural or social stereotypes.
- **Gender differences in engineering and technology:** All groups identify a strong male predominance in engineering and technology fields, such as mechanics, technology, and computer science. This consensus is attributed to cultural influences and traditional male interests in areas like cars and practical work. The mixed group links male interest to financial motivations and women's choices to personal preferences. The girls' group delves into childhood influences, lack of encouragement, and perceptions of these professions as less interesting or motivating for women. The boys' group attributes male dominance to differential upbringing, emphasizing practical and technological skills for boys and domestic or delicate roles for girls.
- **Stereotypes and inequalities:** Across groups, there is agreement on the role of gender stereotypes in shaping professional choices, with practical and physical tasks often linked to men and caring roles to women. Wage inequalities are universally acknowledged, with men generally earning more. However, the depth of exploration differs. The mixed group broadly examines cultural stereotypes and ongoing disparities in male-dominated fields. The girls' group highlights salary gaps tied to cultural barriers and women's limited access to prestigious roles. Boys justify wage disparities by citing men's greater availability for demanding work or overtime, alongside the impact of domestic divisions on women's opportunities.
- **Professional choices and influences:** All groups recognize the influence of family, culture, and society on career decisions, along with individual interests shaped by these factors. The mixed group takes a general approach, discussing choices without deeply addressing external barriers. The girls' group emphasizes cultural obstacles, such as the perception of engineering as a "man's field", and societal resistance faced by women. Boys link career choices to historical divisions of labor, where men traditionally assumed practical and physical roles.
- **Perceptions of Technology:** A shared acknowledgment exists that women use technology daily but often do not envision themselves in technological professions. These professions are perceived as less engaging for women. The mixed group attributes women's lack of interest to cultural factors and low representation. The girls' group examines the deeper cultural undervaluing of women pursuing careers in technology. Boys associate women's disinterest with historical stereotypes connecting them to domestic roles.

- **Proposals for change:** There is unanimous agreement on the need for educational and cultural reforms to reduce gender stereotypes. All groups see value in positive role models—women in technology and men in traditionally feminine roles—to challenge prejudices. However, their focus varies. The mixed group emphasizes encouraging diverse choices without deeply addressing cultural barriers. The girls' group underscores cultural resistance as a significant hurdle, highlighting the difficulty of breaking entrenched stereotypes. Boys acknowledge the potential of younger generations to challenge traditional gender roles and share responsibilities.

#### 4.1.2. Pre-Service Elementary School Teachers

The thematic analysis of the responses highlights persistent gender disparities in professional fields related to STEM fields. Across the groups, common themes emerge, underscoring both structural barriers and cultural stereotypes that perpetuate gender imbalances.

- **Gender disparities in science and mathematics professions:** Participants consistently acknowledged gender disparities in science and mathematics, with men being more represented than women. Commonly cited factors included stereotypes portraying women as less intelligent, rational, or capable, discouraging their participation. The wage gap was frequently highlighted, with women earning less than men for similar roles. Maternity leave and perceived maternal responsibilities were identified as significant obstacles, contributing to hiring biases and limiting career advancement. The lack of visible female role models further exacerbates the issue, reducing aspirations among young women.
- **Gender disparities in engineering and technology professions:** Engineering and technology fields were described as even more male-dominated than science and mathematics. Women are underrepresented in numbers and leadership positions. Persistent stereotypes cast these professions as "male domains", creating cultural barriers. While some subfields, like chemical engineering, show more gender balance, others, such as mechanical or computer engineering, remain overwhelmingly male-dominated. This variation suggests that perceptions of alignment with traditionally "feminine" qualities influence women's participation.
- **Societal and structural barriers:** Participants highlighted societal and institutional barriers that limit women's participation across STEM fields. Disparities in pay, treatment, and recognition were noted as pervasive issues. Women are less likely to be promoted to leadership positions or to have their contributions equally valued. The undervaluation of women's academic qualifications compared to men's perpetuates inequality, particularly in engineering and technology. Family responsibilities, especially caregiving expectations, were identified as central obstacles, often influencing women's career choices and limiting opportunities in higher-paying or more demanding fields.
- **Influence of stereotypes and visibility:** Stereotypes play a significant role in shaping career decisions and reinforcing gender-based norms. The perception of certain fields as more suited to one gender unconsciously guides educational and professional paths. The lack of visibility of female scientists and engineers was identified as a critical issue, reinforcing male dominance in STEM. Workplace environments were often described as favoring men, which perpetuates systemic gender gaps.

## 4.2. Phase 2 Facts Analysis

### 4.2.1. Ninth-Grade Students

The analysis of the mixed, girls', and boys' groups highlights both commonalities and differences in their perceptions of gender differences in STEM fields.

- Perceptions of gender differences in sciences and mathematics: All groups were surprised to find that the actual gender gap was smaller than expected. This revelation challenged their assumptions and led to reflections on societal changes that may have contributed to narrowing the gap. Discussions across all groups also touched on the idea that the gender gap might be decreasing due to increased opportunities for women.
- Perceptions of gender differences in engineering and technology: Participants universally recognized that men strongly outnumbering women in engineering and technology was unsurprising, reflecting preexisting societal norms and stereotypes about these professions.
- Perspective on gender gaps: The girls' group showed more awareness of societal discrimination and cultural barriers affecting women in male-dominated fields, particularly in areas like Information and Communication Technology (ICT). The boys group attributed the disparity to differences in interest, suggesting that men are naturally more drawn to technology-related fields than women.
- Gender pay gap: Only the girls' group explicitly highlighted wage inequalities, noting that women often face unequal pay even when performing the same roles or working harder. The mixed and boys' groups did not directly address this aspect, focusing more on professional choices and interest alignment. Some girls and boys, although a minority, justified the gender pay gap by saying that men do more physically demanding work.
- Future outlook: Some participants were optimistic, believing that societal changes could reduce gender gaps. Others thought the trends might remain constant due to cultural and systemic barriers. The girls' groups expressed hope for change, believing that societal attitudes are slowly shifting, although challenges remain. While some participants from boys' groups thought gender gaps might remain unchanged, others speculated that changes could occur, especially as technology becomes more integral to all aspects of life.

#### 4.2.2. Pre-Service Elementary School Teachers

The thematic analysis of the responses reveals evolving trends, perceptions, and persistent inequalities over time, with statistical data offering both confirmation and challenges to preconceived notions.

- Gender disparities in sciences and mathematics: There was some surprise with the statistical information. Participants noted that gender differences are minimal, highlighting significant female participation. Some emphasized the return to male dominance post-2019, raising concerns about the sustainability of progress toward gender equity in these fields.
- Gender disparities in engineering and technology: The statistical information was in line with their representations, with men significantly outnumbering women. According to the participants, these disparities suggest limited success in efforts to bridge the gap, particularly in Information and Communication Technologies (ICT).
- Alignment with preconceived notions: Responses regarding alignment with expectations varied. For sciences and mathematics, some findings were consistent with expectations, while others anticipated larger male-dominated gaps. Surprises were often attributed to societal stereotypes influencing assumptions. In engineering and technology, findings largely aligned with preconceived notions of significant gender disparities, with some perspectives underestimating the magnitude of male dominance.
- Impact of societal stereotypes: Societal stereotypes and traditional gender roles significantly influence educational and career choices, shaping both perceptions and realities.

Surprises about gender balance in sciences and mathematics highlight the pervasive influence of societal biases on perceptions.

#### 4.3. Phase 3 Causes and Impacts

##### 4.3.1. Ninth-Grade Students

Based on the analysis of the mixed, girls', and boys' groups, several conclusions were drawn regarding the causes of gender differences in STEM professional areas, as well as the broader impacts on individual choices and society.

- Causes of gender differences in sciences and mathematics: The mixed group identified historical and cultural factors as primary causes, noting a gradual balancing in gender representation within these fields compared to engineering and technology. Girls emphasized personal interests as the main causes for women choosing scientific areas and pointed out that women prioritize more socially accepted areas, such as medicine. Boys perceived sciences and mathematics as relatively gender-balanced, focusing less on specific barriers.
- Causes of gender differences in engineering and technology: All groups highlighted the underrepresentation of women as a significant factor. The mixed group focused on the lack of female role models and male-dominated environments. Girls emphasized the emotional and social challenges faced by women in these environments, including feelings of isolation, and acknowledged the media's role in promoting female representation. Boys attributed the disparities to upbringing and personal interests, noting that girls receive less encouragement to engage with technology early in life.
- Impacts on individual choices and personal/professional fulfillment: The mixed group pointed out that gender-specific environments could discourage participation for both genders. Girls reported emotional and societal pressures, particularly in balancing professional and familial roles, along with societal expectations to conform to traditional roles. Boys recognized the need for action to encourage girls to pursue traditionally male-dominated careers. However, neither girls nor boys believe that social constraints affect them individually, and all say that their own choices are not influenced by gender stereotypes.
- Impacts on society: All groups recognized that gender imbalances hinder societal progress and innovation. The mixed group highlighted the economic and social repercussions, such as reduced diversity and lost potential. Girls underscored the persistence of economic inequalities and traditional roles as obstacles to societal advancement. Boys mentioned that professions often considered "feminine", such as early childhood education, also suffer from stereotypes, discouraging male participation.

##### 4.3.2. Pre-Service Elementary School Teachers

The thematic analysis of the responses reveals multifaceted causes and impacts of gender disparities in STEM professional fields.

- Causes of gender differences in sciences and mathematics: Historical contexts and cultural stereotypes were common themes, with some areas (e.g., health sciences) seen as more aligned with caregiving roles traditionally associated with women. Women often gravitate toward professions perceived as nurturing, such as medicine or teaching. Continued academic involvement by women in these areas helps maintain their presence, even as disparities remain.
- Causes of gender differences in engineering and technology: Gender disparities, which are more pronounced in engineering and technology, were understood to be driven by entrenched stereotypes, societal norms, and structural barriers. These fields are often culturally associated with masculinity, with perceptions of them as "practical" rather

than aligning with women's presumed preferences for "emotional" or "theoretical" work. Stereotypes, such as "computers are for men", limit women's participation. The dominance of men and the lack of support for women-led initiatives exacerbate these challenges, further discouraging women from entering or advancing in these areas.

- Impacts on individual choices and professional development: Gender disparities significantly influence individual choices and career paths, particularly for women. Many responses highlighted how societal expectations steer women toward caregiving or education-related professions, while men face barriers in entering roles like early childhood education due to perceptions about masculinity. While some reported no direct personal impact, others noted subtle ways these norms shape choices, often without conscious recognition.
- Societal impacts: The societal consequences of gender disparities are far-reaching, reinforcing inequalities in education, employment, and wages. Occupational segregation, such as the dominance of men in technology and women in early childhood education, perpetuates wage gaps and stereotypes about appropriate roles for each gender. Defying these norms often carries a stigma, restricting individuals' freedom to choose careers without judgment. These disparities hinder societal progress by limiting equal opportunities and the full utilization of talent across genders.

#### 4.4. Phase 4 Attitudes

##### 4.4.1. Ninth-Grade Students

The analysis reveals commonalities and differences in how gender inequalities are perceived, providing insights into shared priorities and distinct experiences.

- Recognition of gender inequality: Across all groups, there was a clear consensus on the importance of addressing gender inequality. Participants collectively acknowledged that stereotypes play a significant role in shaping personal and professional opportunities, often acting as barriers to individual growth and fulfillment. This shared understanding highlights a recognition of the structural issues that perpetuate inequality and a unified commitment to fostering change. Additionally, participants widely recognized the restrictive nature of gender norms, acknowledging how these stereotypes limit the life choices and experiences of both women and men.
- Safety and daily prejudices: The girls' group brought attention to specific and tangible challenges that women face, emphasizing issues such as personal safety, societal prejudices, and systemic barriers. They highlighted how these obstacles restrict women's freedom and opportunities in both personal and professional spheres. A key concern was the difficulty of entering male-dominated fields, where biases and stereotypes create significant hurdles to progress. In addition to these structural barriers, the group discussed the emotional and psychological toll of societal judgments faced by women who step outside traditional gender roles. These pressures, they noted, can discourage ambition and hinder self-expression, underscoring the multifaceted impact of gender inequality on their lives.
- Cultural pressures on men: The boys' group highlighted the societal pressures men face to adhere to traditional roles, particularly in professional and emotional contexts. They pointed out the stigma associated with pursuing careers traditionally labeled as "feminine", such as nursing or kindergarten education, which often discourages men from exploring these paths despite personal interest or aptitude. The social pressure on men to be economically successful and provide for the family is a heavy burden, and boys believe that girls have more options, they can rely on marriage to achieve economic stability. Additionally, they reflected on the restrictive cultural norms that

discourage emotional vulnerability, noting how these expectations lead to the harmful suppression of emotions.

- Cultural resistance and gender stereotypes: Participants across all groups acknowledged that, despite some progress, deeply ingrained stereotypes continue to shape societal expectations and remain difficult to dismantle. The effects of these stereotypes, however, vary between genders. Girls highlighted how traditional roles often limit their choices, particularly in terms of domestic responsibilities and career advancement. They emphasized the disproportionate burden of unpaid work placed on women, which restricts opportunities for personal growth and professional achievement. Meanwhile, boys focused on the rigid expectations of masculinity that society imposes, such as the need to be financially dominant or emotionally stoic.

#### 4.4.2. Pre-Service Elementary School Teachers

The thematic analysis highlights a consensus on the importance and necessity of addressing gender disparities in professional fields.

- Benefits of inclusive representation: Across the groups, the fundamental rationale for change was centered on the principles of fairness, equality, and opportunity. Many groups emphasize that both men and women bring valuable contributions to all professional fields, and fostering a balanced representation is beneficial for innovation, productivity, and societal progress.
- Eliminating discrimination and stereotypes: There's a strong emphasis on dismantling biases to ensure children and future generations are not subjected to the same prejudices. They highlighted the desire to dismantle discriminatory practices and stereotypes that have long perpetuated inequalities.
- Addressing inequalities: Groups highlight the need to reduce gaps in opportunities, salaries, and credibility between genders by providing equal working conditions. Participants argue for equality of rights and opportunities as a fundamental human principle, reinforcing the idea that gender should never be a barrier to success or participation in any field.
- Promoting autonomy and freedom of choice: The responses also reflect a deep concern for individual autonomy and freedom of choice. They argue that it is essential to allow individuals to pursue their careers and education without fear of societal judgment or gender-based limitations.

### 4.5. Phase 5 Strategies

#### 4.5.1. Ninth-Grade Students

The analysis of the responses from mixed, girls', and boys' groups regarding initiatives to promote gender equality in STEM professions reveals both shared perspectives and unique insights.

- Education as a tool for change: Education emerged as a central theme across all groups, recognized as a critical means to dismantle stereotypes and foster equality. The mixed group highlighted the importance of inclusive educational programs that engage all students equally, such as debates and workshops designed to challenge societal norms and broaden career perspectives. The girls' group emphasized the need for targeted interventions aimed specifically at young women, advocating for initiatives that connect them with female role models in STEM and foster environments where they can explore their interests without fear of judgment. The boys' group suggested that educational initiatives should also address the pressures of traditional masculinity, focusing on cultural expectations that prioritize financial success over personal interest and restrict emotional expression or exploration of non-traditional career paths.

- **Early socialization and gender norms:** There was unanimous recognition of the profound influence of early socialization on career choices and perceptions of gender roles. The mixed group underlined the importance of creating educational environments that question and counteract societal norms introduced during childhood. Girls focused on the need for interventions to combat early discouragement from STEM pursuits, calling for programs that challenge the gendered marketing of toys and foster an interest in traditionally male-dominated fields through mentorship. Boys concentrated on dismantling stereotypes that limit their ability to pursue interests outside conventional masculine roles, advocating for initiatives that normalize male engagement in fields often perceived as feminine, such as caregiving and education.
- **Role models and representativity:** The visibility of role models was consistently emphasized as a key strategy for promoting gender equality. The mixed group proposed a general approach, suggesting exposure to diverse professionals who have succeeded in challenging gender norms. Girls highlighted the importance of showcasing women in STEM, advocating for their inclusion in school curricula and mentorship opportunities to inspire future generations. Boys, on the other hand, stressed the need for balanced representation, suggesting that showcasing men in traditionally female-dominated professions could normalize a broader range of career choices for all genders.
- **Targeted initiatives for each gender:** The differences in experiences and sensitivities led to unique proposals for targeted initiatives. The mixed group advocated for general initiatives that would benefit all students, focusing on broad-based programs like STEM fairs and interactive learning opportunities without a specific gender focus. Girls proposed measures to address the systemic barriers they face, emphasizing the importance of safe spaces and workshops that build resilience and confidence in navigating male-dominated fields. Boys, meanwhile, highlighted the importance of addressing the restrictive nature of traditional masculinity, suggesting programs that encourage boys to embrace emotional expression and diverse career aspirations.
- **Cultural change and stereotype deconstruction:** All groups recognized that cultural shifts are necessary to achieve true gender equality. The mixed group suggested awareness campaigns that highlight the societal impact of gender stereotypes and the benefits of diversity in professional fields. Girls proposed targeting parents and educators to address unconscious biases that may discourage girls from pursuing STEM careers. Boys emphasized redefining societal expectations of masculinity, advocating for campaigns that broaden the definition of success and normalize men's participation in non-traditional careers.

#### 4.5.2. Pre-Service Elementary School Teachers

The thematic analysis reveals a shared understanding of the importance of promoting gender equality in education, particularly in STEM. The groups collectively emphasize the role of education in challenging gender stereotypes and inspiring interest in traditionally male-dominated fields. Several strategies were proposed to achieve this goal:

- **Early exposure to diverse fields:** Many groups suggested introducing activities that expose children to various professional fields, particularly those traditionally associated with one gender.
- **Showcasing role models:** Some groups focus on presenting both male and female role models in STEM fields. Highlighting the achievements of prominent figures from underrepresented genders in specific professions aims to inspire children and broaden their aspirations.
- **Interactive and inclusive activities:** Participants proposed creating games and science fairs that encourage collaborative interaction across various subjects. This approach

fosters interest and reduces the influence of gender stereotypes by normalizing participation in all fields.

- Professional visits and demonstrations: Some groups advocate for bringing professionals into schools to demonstrate that gender should not limit career choices. Examples include inviting male kindergarten teachers to discuss their experiences in early education or female mechanics to share their expertise.
- Hands-On exploration and awareness: Practical activities, like challenges or experiments, were identified as having potential to help children explore their interests without preconceived biases. These efforts should be coupled with discussions on the freedom to pursue personal passions, independent of societal expectations.
- Visibility and information: Most groups emphasize the importance of making all professions visible to students and providing clear, unbiased information about career paths. This involves integrating discussions about gender equality into the broader curriculum.

When asked about existing initiatives that promote gender equality in STEM fields, the responses highlight varying levels of awareness. Some groups expressed limited awareness, underscoring the need for greater visibility and dissemination of such programs. Other groups identified some initiatives:

- KidZania, an experiential learning center where children can explore various professions, providing a gender-neutral environment to experiment with diverse career paths.
- The scouting movement, which offers a platform for skill development and exposure to different fields without a focus on gender.
- Quotas designed to promote the inclusion of minorities, which can indirectly support gender equality in STEM professions.

The table below (Table 4) summarizes the main findings.

**Table 4.** Main findings.

Category	9th-Grade Girls	9th-Grade Boys	Pre-Service Teachers
Gender Disparities in STEM Fields	<ul style="list-style-type: none"> <li>- Acknowledge that science/math fields, while male-dominated, offer more opportunities for women than engineering/tech.</li> <li>- Emphasize barriers due to societal norms and gender stereotypes.</li> </ul>	<ul style="list-style-type: none"> <li>- Recognize male dominance in STEM but emphasize equal intellectual abilities.</li> <li>- Focus less on societal barriers and more on personal choice and interest.</li> </ul>	<ul style="list-style-type: none"> <li>- Highlight persistent gender disparities in STEM due to stereotypes and structural obstacles.</li> <li>- Identify the wage gap and maternity leave as barriers.</li> </ul>
Cultural and Societal Influences	<ul style="list-style-type: none"> <li>- View culture and upbringing as key reasons for gender gaps.</li> <li>- Identify societal barriers to wage gaps and women’s exclusion from prestigious roles.</li> <li>- Believe women are discouraged from pursuing STEM from an early age.</li> </ul>	<ul style="list-style-type: none"> <li>- Attribute gender gaps to historical labor divisions.</li> <li>- See men as naturally drawn to hands-on and tech-related fields.</li> <li>- Highlighted the societal pressure to conform to masculine norms in career paths.</li> </ul>	<ul style="list-style-type: none"> <li>- Emphasize cultural and institutional barriers limiting women’s STEM participation.</li> <li>- Recognize lack of female role models as a critical issue.</li> </ul>

Table 4. Cont.

Category	9th-Grade Girls	9th-Grade Boys	Pre-Service Teachers
Perceptions of Technology & Careers	<ul style="list-style-type: none"> <li>- State that women use technology daily but are not encouraged to pursue careers in it.</li> <li>- Consider that cultural undervaluing of women in tech is a major factor.</li> </ul>	<ul style="list-style-type: none"> <li>- Believe historical stereotypes linking women to domestic roles affect their career interests.</li> </ul>	<ul style="list-style-type: none"> <li>- Recognize STEM as male-dominated, particularly in engineering and tech.</li> <li>- Stereotypes about “masculine” fields reinforce disparities.</li> </ul>
Proposals for Change	<ul style="list-style-type: none"> <li>- Emphasize breaking cultural resistance to gender equality.</li> <li>- Stress the need for female role models in STEM.</li> </ul>	<ul style="list-style-type: none"> <li>- Suggest younger generations will naturally challenge traditional gender roles.</li> <li>- Acknowledge the need for change but focus less on cultural resistance.</li> </ul>	<ul style="list-style-type: none"> <li>- Call for educational reforms, gender balance in leadership, and greater female representation in STEM.</li> </ul>
Strategies for Addressing Inequality	<ul style="list-style-type: none"> <li>- Advocate for mentorship programs and targeted support for girls in STEM.</li> <li>- Emphasize cultural shifts through education.</li> </ul>	<ul style="list-style-type: none"> <li>- Propose broad STEM programs for all students.</li> <li>- Suggest redefining masculinity to allow diverse career interests.</li> </ul>	<ul style="list-style-type: none"> <li>- Recommend early exposure to diverse career options, visibility of female professionals, and inclusive educational activities.</li> </ul>

## 5. Discussion

### 5.1. Awareness of Gender Inequalities in STEM and Policy Implications

From the very beginning of the workshop, both students and pre-service teachers, in addition to sharing their perspectives on the gender gap in STEM fields, recognized the need for change to foster greater equity across all areas, demonstrating a strong awareness of the inequalities that require attention. Aligned with the latest data (CIG 2024), the observations of students and pre-service teachers highlighted the persistence of gender stereotypes and inequalities in career choices, noting a greater gender balance in sciences and mathematics, but a pronounced male dominance in engineering and technology. Their insights collectively highlighted the enduring influence of societal norms and stereotypes on professional choices, demonstrating their awareness that gender stereotypes in STEM perpetuate biases and hinder women’s educational and career opportunities (Master and Meltzoff 2020; Miller et al. 2018). These findings reflect broader systemic and policy debates on gender equity in STEM, demonstrating how deeply ingrained societal norms continue to influence professional choices. Addressing these disparities requires institutional and policy-driven initiatives, such as curriculum reforms, scholarship programs for underrepresented genders, and inclusive hiring policies to ensure equitable representation in STEM fields (Monteiro et al. 2024).

### 5.2. Perceptions of Gender Disparities and Their Impact on Institutional Change

After analyzing the statistical data provided by the researchers, distinct differences emerged in how gender disparities were perceived by students and pre-service teachers. Among student groups, girls demonstrated a stronger awareness of societal and cultural barriers, frequently citing factors such as stereotypes, lack of encouragement, self-doubt, and historical discrimination (Chan 2022; Šimunović and Babarović 2020). In contrast, boys

tended to attribute the gender gap to natural differences in interests, framing it as a matter of personal preference rather than structural inequality. Discussions about the gender pay gap (Zajac et al. 2025) were largely led by the girls, who pointed out wage disparities and unequal treatment. Boys, however, either overlooked this issue or justified wage differences by referencing the physical demands of certain jobs. These differing perspectives suggest that girls exhibited a deeper understanding of structural inequalities highlighted in research (Izquierdo and Fabra 2024; Villarroya and Barrios 2022). These contrasting views highlight the critical role of education in shaping awareness and attitudes toward gender disparities. The findings suggest that teacher education must integrate critical discussions on gender equity, equipping future educators with the tools to challenge ingrained biases and foster institutional change.

### 5.3. Causes and Consequences of Gender Stereotypes in Education

Reflecting on the causes and impacts, students recognized the influence of gender dynamics on educational choices and professional fulfillment. Girls highlighted societal pressures to balance multiple roles and the emotional challenges that accompany them (Ferreira 2017), while boys noted that professions often labeled as “feminine”, such as early education, face stigma that discourages male participation and reinforces gender stereotypes (Ferreira and Silva 2023). Notably, despite their awareness of social pressures, neither girls nor boys reported feeling personally constrained by stereotypes in their individual choices. This suggests that being aware of social constraints does not necessarily translate to understanding their full impact on one’s personal life. Pre-service teachers highlighted how gender dynamics, often shaped by unconsciously internalized norms, play a significant role in influencing individual career choices and professional development. They emphasized the broader societal consequences of gender disparities, such as occupational segregation, wage gaps, and the reinforcement of stereotypes about gendered roles (Evagorou et al. 2024). These inequalities, they observed, not only constrain individuals’ freedom to pursue careers without societal judgment but also hinder overall societal progress. By limiting the full utilization of talent across genders, these disparities perpetuate biases in economic, educational, and cultural spheres, ultimately impeding efforts toward equity and inclusion (European Institute for Gender Equality 2017). These findings contribute to understanding the effectiveness of gender equality initiatives in education by underscoring the need for early interventions that challenge stereotypes before they become ingrained (Monteiro et al. 2024).

### 5.4. Addressing Gender Gaps in STEM Through Education and Representation

When analyzing attitudes toward the gender gap in STEM, there was a shared recognition across all student groups of the importance of addressing gender inequality by dismantling stereotypes and promoting equal opportunities. However, the experiences and priorities varied between genders. Girls focused on systemic barriers and the emotional burdens that disproportionately affect women, emphasizing the impact of societal expectations (Master 2021). In contrast, boys concentrated on challenging traditional masculine ideals, highlighting how these norms restrict their freedom and emotional well-being (Ferreira and Silva 2023). The pre-service teachers underscored the importance of inclusive representation, highlighting how the contributions of both men and women across all fields drive innovation, productivity, and societal progress while upholding principles of fairness, equality, and opportunity (European Institute for Gender Equality 2017). They strongly advocated the elimination of discrimination and stereotypes, emphasizing the need to dismantle biases to ensure future generations are not subjected to the same prejudices. By addressing systemic gender disparities, they aimed to foster a more inclusive and equi-

table society. Their reflections suggest that gender equality initiatives should go beyond awareness-raising and actively implement measures to promote representation, such as mentorship programs, inclusive curricula, and workplace policies that support diversity. The effectiveness of these initiatives depends on their ability to address both structural and cultural barriers simultaneously.

#### *5.5. The Role of Education in Transforming Gender Norms*

Both students and pre-service teachers acknowledge education as a powerful tool for advancing gender equality. However, their approaches to promoting gender equality in STEM and technology professions differ significantly, reflecting the distinct experiences and contexts of ninth-grade students and pre-service elementary school teachers. For ninth-grade students, the focus is on how gender norms directly impact career aspirations and choices (Chan 2022; Ferreira 2017). Their perspectives are shaped by personal experiences. The strategies proposed by students are largely peer-focused, addressing their immediate educational and social environments. Pre-service elementary school teachers, on the other hand, take a broader and more systemic approach, emphasizing the need to influence younger children before stereotypes take hold (Stephenson et al. 2022). They propose initiatives such as introducing diverse role models, professional visits, and hands-on exploration to challenge gender norms. Their strategies are rooted in structured activities designed to foster inclusivity and broaden career aspirations in elementary-aged children. Teachers recognize the transformative power of education in reshaping societal norms, advocating for early exposure to diverse professional fields and integrating discussions about gender equality into the broader curriculum (Schiefer et al. 2021). Unlike students, their focus extends beyond their own experiences to create foundational changes in educational practices. However, the limited awareness of existing initiatives suggests a gap in accessibility or communication about these programs. This highlights the need for increased efforts to promote and integrate established gender-equality initiatives within educational systems.

#### *5.6. Comparing Student and Teacher Perspectives on Gender Equity*

The understanding of gender dynamics and barriers to equity varies significantly between ninth-grade students and pre-service teachers, reflecting differences in depth of analysis, focus, and approach. Ninth-grade students provide initial, surface-level observations primarily shaped by societal and cultural norms, grounded in their immediate experiences and limited exposure to critical analysis. In contrast, pre-service teachers demonstrate a more comprehensive and nuanced understanding of gender disparities, informed by their educational training and exposure to data and historical contexts.

When addressing barriers to gender equity, the two groups diverge in their focus. Ninth-grade students often emphasize societal norms and personal interests as the primary factors influencing gender disparities, frequently externalizing the issue. Girls in this group tend to show greater awareness of societal inequalities, while boys are more likely to attribute disparities to individual preferences. Pre-service teachers, on the other hand, identify more complex and systemic barriers, such as institutional obstacles, pervasive stereotypes, and systemic inequalities. Their reflections are shaped by a broader understanding of how societal norms influence individual experiences, highlighting the structural challenges to achieving equity.

These differences are also reflective of the distinct cognitive and social development stages of each group. Ninth-grade students' insights are rooted in personal and cultural experiences, often focusing on immediate, practical challenges like prejudices, cultural pressures, and the emotional toll of restrictive gender roles. Meanwhile, pre-service teachers adopt a critical, solution-oriented perspective that emphasizes systemic reform and

equity in professional environments. Their approach extends beyond personal experience, advocating for systemic change to address the societal and professional consequences of gender inequality.

Education plays a pivotal role in shaping these differing perspectives. Pre-service teachers' broader exposure to data and historical trends enables them to develop a deeper and more systemic understanding of societal inequities. This contrasts with the limited exposure of ninth-grade students, who rely more heavily on their immediate contexts to inform their views. Despite these differences, both groups share a commitment to promoting gender equity and dismantling stereotypes. Ninth-grade students prioritize the emotional and practical impacts of gender norms, while pre-service teachers advocate long-term, systemic solutions aimed at fostering inclusivity and fairness. Together, these perspectives provide complementary insights, highlighting both the personal and structural challenges of gender inequality and the importance of addressing these issues at multiple levels of society.

## 6. Conclusions

This research highlights the significance of utilizing gender-specific groups to analyze gender dynamics, particularly in the context of STEM education. Such groups offer nuanced insights into participants' perspectives on the interrelations between gender dynamics and STEM fields. For instance, discussions within boys' groups emphasized not only the need to promote girls in STEM but also the critical importance of challenging male stereotypes and addressing broader inequalities. This is an important finding, as it can be valuable for future research exploring gender dynamics in STEM fields.

Although students acknowledge the influence of gender stereotypes and social restrictions on career choices, they often believe they are personally unaffected by these factors. This highlights the need for initiatives that encourage students to engage in deeper reflection on how gender stereotypes may shape their own decisions. Such initiatives can empower them to make more informed and conscious choices about their education and careers.

Both students and pre-service teachers share a clear understanding of the pivotal role of education in promoting gender equality. However, neither group is familiar with existing national programs and initiatives aimed at achieving gender equality in STEM. This highlights a significant gap in communication and outreach, underscoring the urgent need to more effectively publicize and integrate these initiatives into educational settings. Nevertheless, pre-service teachers suggest diverse children-centered strategies to deconstruct professional gender stereotypes. Those strategies include familiarization with role models and more inclusive professional environments, as well as simulation activities related to those environments.

When discussing gender dynamics in STEM, the conversation often gravitates toward the barriers and challenges faced by girls and women. This focus is undoubtedly important, as women have been historically underrepresented in STEM fields and continue to face structural, cultural, and societal barriers. In this research, participants, mainly boys, highlighted the importance of a broader and more inclusive approach that acknowledges and addresses the stereotypes and inequalities that affect all genders. The rigid framing of "masculine" versus "feminine" traits perpetuates a binary understanding of gender, reinforcing restrictive norms that harm everyone.

Beyond addressing existing gaps, questioning the gender binary itself could disrupt rigid stereotypes, fostering a broader cultural shift. By challenging traditional notions of masculinity and femininity, educators and policymakers can create environments that not only question but actively dismantle restrictive norms. This cultural transformation has

the potential to positively impact how gender stereotypes are understood and overcome, ultimately contributing to the reduction of the gender gap in STEM. A comprehensive approach that includes education, awareness, and systemic change is essential to achieving lasting progress in this field.

### *6.1. Limitations of the Structured Workshop*

The structured workshop aimed to provide a comprehensive exploration of gender and STEM careers; however, several limitations must be acknowledged in evaluating its findings and implications.

- Potential social desirability bias—the presence of a researcher during the workshops may have influenced participants' responses, introducing a form of social desirability bias. Participants, as students, may have felt compelled to provide answers they believed were socially acceptable or aligned with the research objectives rather than expressing their genuine thoughts and experiences. This dynamic could have affected the authenticity of discussions, particularly when addressing sensitive topics related to gender stereotypes and biases.
- Limited generalizability due to sample size and educational context—the study's sample size and specific educational settings limit the broader applicability of the findings. With only 36 ninth-grade students and 23 pre-service elementary school teachers participating, the conclusions drawn are context-dependent and may not be representative of broader educational populations. Additionally, the workshop was conducted in Portugal within a particular institutional framework, making it difficult to generalize the findings to other cultural and educational contexts without further comparative studies.
- Influence of group-based format on response dynamics—the workshop's group-based design likely shaped participant interactions, particularly in gender-segregated sessions. While these formats can foster open discussions within homogeneous groups, they may also reinforce existing perspectives rather than challenge them. On the other hand, gender-segregated groups can also create a safe space for open discussions, address gender-specific challenges, and foster confidence among participants.
- Time constraints limiting depth of reflection—each phase of the workshop was limited to approximately 20 min, which may not have allowed for deep reflection and nuanced discussion. Given the complexity of gender-related issues in STEM, participants may have needed more time to critically engage with the material and fully articulate their thoughts. The time restrictions could have led to a superficial exploration of some concepts, preventing more profound insights and a thorough analysis of participants' perspectives.

Despite these limitations, the workshop provided valuable qualitative insights into gender and STEM dynamics. Addressing these constraints in future research could enhance the robustness and applicability of findings. For instance, extending workshop durations, incorporating anonymous response mechanisms to reduce bias, and diversifying participant selection across multiple educational institutions could contribute to a more comprehensive understanding of gender perceptions in STEM education.

### *6.2. Future Research Directions*

One critical area for future research is curriculum design and the representation of gender in STEM-related subjects. Examining how textbooks, instructional materials, and course content portray gender roles can provide insights into implicit biases that may influence students' perceptions of STEM fields. Research in this area could explore

whether existing curricula reinforce traditional gender stereotypes or promote inclusivity and diversity.

Another important avenue is teacher training and pedagogical approaches that may reinforce or challenge gender biases. Teachers play a pivotal role in shaping students' attitudes toward STEM subjects. Investigating the extent to which educators are aware of gender biases, as well as the effectiveness of training programs designed to mitigate them, could inform strategies for fostering more equitable classroom environments.

Additionally, research is needed on the effectiveness of existing STEM gender equality initiatives and their accessibility to students and educators. Many programs aim to encourage female participation in STEM, but their actual impact and reach remain unclear. Future studies could assess which interventions—such as mentorship programs, scholarships, or outreach activities—are most successful in reducing gender gaps and whether these initiatives are equally available to students from different socioeconomic backgrounds.

Finally, an often-overlooked factor in gender representation in STEM education is parental engagement. Parents play a crucial role in shaping their children's academic interests and career aspirations. Research that incorporates parental perspectives could provide a more comprehensive understanding of how family expectations, encouragement, and biases influence students' decisions to pursue STEM fields. Investigating how parental support and awareness programs can contribute to gender equity in STEM would be a valuable addition to the existing body of research.

Future research in gender and STEM should adopt a multi-dimensional approach that considers the diverse experiences of individuals across different identities and life stages. By addressing the complex and intersectional barriers that contribute to gender inequality, researchers can develop more effective strategies for fostering inclusive and equitable STEM fields. Continuous exploration of these areas will not only benefit underrepresented groups but also contribute to the overall innovation and growth of STEM disciplines.

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