CONHECIMENTO & DIVERSIDADE
ISSN 2237-8049
UnilaSalle Editora

WOMEN IN COMPUTER SCIENCE COURSES: MOTIVATING FACTORS, BARRIERS, AND INSTITUTIONAL INITIATIVES FOR ENTRY, RETENTION, AND SUCCESS

MULHERES EM CURSOS DE COMPUTAÇÃO: FATORES MOTIVADORES, BARREIRAS E INICIATIVAS INSTITUCIONAIS PARA O INGRESSO, PERMANÊNCIA E ÊXITO

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ABSTRACT

The underrepresentation of women in Computer Science and STEM courses constitutes a global challenge that demands multidimensional analysis. This article presents a mixed-methods approach to systematic literature review (SLR), analyzing 27 publications (2020-2024) on the entry and retention of women in Computer Science courses in national and international contexts, as well as on institutional initiatives that contribute to the success of female students. The research identified three central dimensions: (1) motivating factors for entry (personal interest, social influences, institutional experiences); (2) structural barriers to retention (lack of mentoring, social isolation, self-efficacy deficit, absence of affirmative action policies); (3) emerging institutional initiatives (welcoming programs, inclusive classes, innovative teaching resources). The results show that barriers predominate in the social and institutional dimensions, suggesting that public and institutional policies are essential to promote gender equity in the field. This study contributes to the debate on strategic actions capable of increasing the participation of women in STEM careers, especially in Computer Science courses, which are the focus of this study.

Keywords: Gender Equality, STEM, Computer Science, Higher Education, Institutional Policies.

RESUMO

A sub-representação de mulheres em cursos de Computação e na área STEM constitui um desafio global que demanda análise multidimensional. Este artigo apresenta uma revisão sistemática de literatura (RSL) de abordagem mista, analisando 27 publicações (2020-2024) sobre ingresso e permanência de mulheres em cursos de Computação em contextos nacionais e internacionais, bem como sobre iniciativas institucionais que contribuem para o êxito das estudantes. A pesquisa identificou três dimensões centrais: (1) fatores motivadores para ingresso (interesse pessoal, influências sociais, experiências institucionais); (2) barreiras estruturais à permanência (falta de mentoria, isolamento social, déficit de autoeficácia, ausência de políticas afirmativas); (3) iniciativas institucionais emergentes (programas de acolhimento, turmas inclusivas, recursos didáticos inovadores). Os resultados evidenciam que as barreiras predominam nas dimensões social e institucional, sugerindo que políticas públicas e institucionais são essenciais para promover equidade de gênero na área. O estudo contribui para o debate sobre ações estratégicas capazes de ampliar a participação de mulheres em carreiras STEM, especialmente nos cursos de Computação que compõem o foco deste estudo.

Palavras-chave: Equidade de Gênero, STEM, Computação, Ensino Superior, Políticas Institucionais.

Introduction

Women represent the majority of enrollments in Brazilian higher education (59.1%), according to the National Institute of Educational Studies and Research Anísio Teixeira (INEP, 2023). However, when analyzing the presence of women in the field of Science, Technology, Engineering and Mathematics (STEM), there is a significant reduction in this contingent. International reports reinforce this disparity, as seen in reports from the World Economic Forum (WEF), which records that in the global ranking of gender inequality, Brazil ranks 57th among 146 countries (WEF, 2023), and also points out that jobs in cloud computing, engineering, and artificial intelligence remain as highly male-dominated professions, with women's participation corresponding to only 12%, 15%, and 26%, respectively (WEF, 2019 apud Wimmer, 2021).

Another relevant piece of information is that in countries such as the United States (USA), only 25% of STEM jobs are occupied by women (Beede; Julian, 2011). The situation is even more critical in Computer Science, according to the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2017), with only 3% of people enrolled in higher education courses in this field being women. These scenarios reveal structural inequalities that persist despite educational advances in favor of gender equity in recent decades.

Regarding educational advances, at the international level, gender equity in STEM is part of the commitments of the United Nations (UN) member states through the 2030 Agenda, with the Sustainable Development Goals (SDGs), especially SDG-5 (Gender Equality) and SDG-4 (Quality Education), which highlight the urgency of eliminating barriers and ensuring inclusive and representative environments.

In Brazil, such commitments align with national goals, such as Goal 14.8 of the National Education Plan (PNE 2014–2024), which encourages women's participation in advanced scientific and technological training programs. However, gaps persist between intention and effectiveness, particularly regarding professional choice, retention, and academic success in technological areas.

Beyond quantitative indicators, it is essential to understand the subjective experiences of women who enter Computer Science courses and the tensions experienced in environments predominantly occupied by men. Fostering conditions to amplify the voices of these students is essential for analyzing naturalized inequalities and overcoming historically constructed silences, as discussed by Spivak (2010). Thus, the analysis of gender equity must go beyond statistics and encompass institutional initiatives and policies, pedagogical practices, academic cultures, and management models that structure higher education.

As in the reports presented, scientific literature confirms that women's participation in STEM courses remains significantly lower than men's, both nationally and internationally (Mattauch et al., 2020; Costa et al., 2024a).

However, this disparity is not sustained by cognitive differences, but rather by structural, social, and institutional barriers that condition women's entry and retention in scientific-technological careers (Klanovicz, 2022). Such obstacles frequently materialize in unwelcoming academic cultures that, by naturalizing inequalities, can discourage women's presence in the field and silence their experiences, reinforcing dropout processes in areas where gender asymmetry is historically more pronounced.

Thus, this mixed-methods SLR (Creswell, 2010) seeks to address this gap by integrating qualitative and quantitative evidence with the objective of identifying in the publications that comprised the systematic review, and sharing with readers,

the obstacles and advances related to entry, retention, and success of women in higher education Computer Science courses, as well as the institutional initiatives and policies aimed at promoting gender equity in university spaces.

2. Methodology

This SLR is part of a doutoral research project that aims to analyze the obstacles and advances in access, retention, and success of women in higher education Computer Science courses, identifying structural and institutional factors that influence these processes, as well as existing policies and initiatives in a higher education institution. The study received a favorable opinion from the Research Ethics Committee (CEP), under CAAE number (anonymized). The initial stage involved exploratory studies for theme delimitation and definition of methodological choices capable of conferring solidity to the project.

Understanding the scenario of gender disparity and its implications for women's entry and retention in Computer Science courses required mapping studies conducted in different contexts, institutions, and countries, in order to identify trends, challenges, and policies addressing the overcoming of these inequalities. In this sense, the systematic literature review (SLR) constituted itself as the central methodology for deepening the theme, allowing the production of data with exhaustiveness, representativeness, and methodological rigor.

As Galvão (2019) highlights, the term "systematic review" only becomes meaningful when its methodological choices are explicitly stated, guaranteeing transparency and reliability to the investigative process. For this study, the concept of mixed-method systematic review was adopted, according to Creswell (2010), incorporating qualitative, quantitative, and mixed-methods studies. This approach, especially the qualitative convergence mixed review, makes it possible to transform different types of results into integrated qualitative findings, contributing to the development and refinement of conceptual frameworks.

The robustness of this methodology depends on its replicability and reliability, ensured by the definition of structured protocols, previously tested

search strategies, and rigorous inclusion and exclusion criteria. These elements strengthen the consistency of results and favor comparisons with other studies.

For the operationalization of the SLR, the PARSIFAL software (Perform Systematic Literature Reviews) was used, a freely accessible tool that organizes and manages bibliographic data according to the principles of PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). The guiding questions were defined based on the research objectives: (a) what policies and initiatives promote women's retention in higher education STEM courses with a focus on Computer Science? (b) what factors motivate the entry and/or retention of these students? (c) what gender barriers persist in higher education in Computer Science?

As part of the protocol, it was defined that the selected studies would be in Portuguese and English and would have been published between 2020 and 2024. Four multidisciplinary databases were consulted: SCOPUS, Web of Science, IEEE Xplore, and ACM Digital Library, selected for their coverage in education, STEM, and technology. They also enable free access through the adherence of universities to CAFe (Federated Academic Community), which is promoted by RNP (National Education and Research Network), guaranteeing remote access to content subscribed through CAPES (Coordination for the Improvement of Higher Education Personnel). The choice of consultation bases followed the following criteria, as shown in Table 1 below:

Table 1 – Criteria for Selection of Databases

Database	Coverage	Relevance
SCOPUS	Multidisciplinary: education, social sciences, psychology, law, linguistics, literature, technical and technological areas.	For the STEM theme, related to educational policies.
Web of Science	Comprises the production of articles produced in various countries.	Multidisciplinary subject matter.
IEEE Xplore	Collections of works published by the Institute of Electrical and Electronic Engineers.	Relevance due to its scope of themes on engineering, technology, and Computer Science.
ACM	Publications in the field of Computer Science and Technology.	Depth and relevance of subjects in the field of Technology, Computer Science, and Education.

Source: Prepared by the authors, 2025.

2.1 Conduct of the Study

After the protocol was developed and the search strings were tested, the composition of the SLR proceeded to the stages related to identifying studies in the selected databases. For this purpose, inclusion and exclusion criteria were applied. These criteria were defined to guide the search, refine the data, and select publications capable of providing solid theoretical support for the scientific investigation.

The inclusion criteria were: (a) studies addressing policies related to the entry and retention of women in higher education, published in English or Portuguese; (b) studies whose central theme involved women enrolled in STEM courses, with special attention to research focused on Computer Science programs; and (c) studies discussing motivating factors and barriers experienced by women in STEM courses, since such elements are essential for understanding women's participation and retention dynamics in this field.

Regarding the exclusion criteria: (a) studies that diverged from the central theme of the review or those classified as short papers—having fewer than five pages, which could compromise the depth of analysis—were discarded; (b) duplicate studies across the selected databases were excluded to ensure that each work was counted only once; and (c) studies that did not address higher education programs or that failed to include data related to STEM students were not considered, as these elements were fundamental to the defined research objectives.

After applying the inclusion and exclusion criteria, the selected studies were evaluated according to quantitative parameters established in the protocol. Those that met the quality parameters were analyzed and systematized for identifying the data contained in the publications. The sequence of the stages and the volume of studies distributed across the selected databases are presented in Table 2.

Table 2 – Study Selection Phases

Phases	Web of Science	ACM	IEEE Digital Library	Scopus	No.
Survey in databases with defined string after testing.	215	220	679	92	1206
Removal of duplicate studies indicated by Parsifal.	215	220	676	91	1202
Reading of titles and abstracts of all publications with application of inclusion criteria.	04	14	63	16	97
2nd reading of abstracts applying exclusion criteria, opening the article to verify if full access was available.	02	06	09	14	31
3rd reading for evaluation of the questions proposed in this study, based on qualitative parameters established in the protocol.	01	05	06	13	27

Source: Prepared by the authors, 2025.

Below, the general data obtained are presented, identifying shared characteristics among the studies, as well as theoretical and methodological concepts that helped address the guiding questions of the SLR protocol.

3. Results and discussion

The selected studies covered a publication period from 2020 to 2024, which describes the systematic literature review (SLR) protocol, ensuring updated data, and employing quantitative, qualitative, and mixed-method approaches, which allowed us to observe the broader scenario of the object of this systematic literature review: female underrepresentation in higher education STEM courses, with a focus on Computing, taking into account the publication years of the selected studies.

Twenty-six publications in English and only one originally in Portuguese were found (Klanovicz, 2022).

In the Brazilian context, the 6 studies listed in Table 4 address gender disparity in STEM courses, revealing that this inequality is also present in national higher education. Furthermore, these studies highlight the relevance of the topic and the scientific quality of Brazilian researchers.

However, this global insertion occurs amid relevant structural challenges, such as language barriers, inequalities in access to funding, and visibility limitations

in indexed databases. Such obstacles not only reduce the reach of Brazilian research but also compound gender inequalities, amplifying the difficulties faced especially by women researchers in consolidating their academic and scientific careers (Mattauch et al., 2020).

In Table 3, it is possible to access the titles, authors, and years of publications where it is observed that only one of the works is in Portuguese. It is the title "Women and Engineering in Southern Brazil: Gender, History and Science," authored by Klanovicz (2022).

Table 3 – Titles, Authors, and Publication Year

No.	Titles	Authors	Year
01	Engineering Identity and Smartness Identity as they Relate to Women's Participation in Engineering	Wallwey et al.	2024
02	Examining Intention to Major in Computer Science: Perceived Potential and Challenges	Sibia et al.	2020
03	Predictors of university students' intentions to enroll in computer programming courses: a mixed-method investigation	Zheng et al.	2024
04	Factors That Influence Career Choice in Engineering Students in Spain: A Gender Perspective	Gomez et al.	2022
05	BI-based methodology for analyzing higher education: A case study of dropout phenomenon in information systems courses	Menolli et al.	2020
06	Implementation of Virtual Training: The Example of a Faculty of Computer Science during COVID-19 for Sustainable Development in Engineering Education	Rajab et al.	2022
07	A Descriptive Quantitative Exploration of College Students of Promise During the COVID-19 Pandemic	Womack et al.	2023
08	Inclusion of women to ICT engineering – lessons learned	Lagesen et al.	2022
09	Improving student engagement, retention and success in online learning	Stone	2021
10	The Early Bird Gets the Worm: Major Retention in CS3	Christoph et al.	2021
11	Undergraduate-led survey class to improve cs education for new students	Zhang et al.	2020
12	Assessing the impact of a distance-based spatial factor on retention in the U.S. colleges	Varol et al.	2021
13	With a Rise in Computing Disciplines Comes a Greater Choice of Computing Degrees in Higher Education	Redmond	2022
14	State-of-the-Art Review on Current Approaches to Female Inclusiveness in Software Engineering and Computer Science in Higher Education	Kovaleva et al.	2024
15	A Comparative Study on the Support in Engineering Courses: A Case Study in Brazil and Spain	García et al.	2020
16	Women's Journey in STEM Education in Brazil: A Rapid Review on Engineering and Computer Science	Costa et al.	2024a
17	Heroine's Learning Journey: Motivating Women in STEM Online Courses Through the Power of a Narrative	Costa et al.	2024b
18	Evidence for Teaching Practices that Broaden Participation for Women in Computing	Morrison et al.	2022
19	Confidence, Connection, and Comfort: Reports from an All-Women's CS1 Class	Ying et al.	2021
20	An Educational Digital Game Driven Strategy to Support the Teaching-Learning of Algorithms and Motivate Female Information Systems Students	Yamashita et al.	2024
21	Women and Engineering in Southern Brazil: Gender, History and Science	Klanovicz	2022
22	A bibliometric approach for detecting the gender gap in computer science	Mattauch et al.	2020
23	Comparing success of female students to their male counterparts in the STEM fields: an empirical analysis from enrollment until graduation using longitudinal register data	Vooren et al.	2022

24	Potential Factors for Retention and Intent to Drop-out in Brazilian Computing Programs	Duran et al.	2023
25	Measuring and Fostering Diversity in Affective Computing Research	Hupont et al.	2024
26	Factors Affecting Women's Choice of Learning Engineering and Technology Education in Ethiopia	Melak et al.	2021
27	Gender Disparity in Engineering Courses in Brazil	Castro et al.	2024

Source: Prepared by the authors, 2025.

Considering the total number of publications analyzed in this study, there is a predominance of qualitative research approaches, corresponding to 18 identified works. Quantitative methods were used in 4 studies, while 5 publications adopted mixed-method methodology (qualitative and quantitative).

3.1. Distribution of research by location

In addition to analyzing the methodological typology employed in the studies, the locus of investigation reported in the texts themselves was also examined. For this purpose, the authors' country of origin was not considered, but rather the country where the research was actually conducted.

This category includes studies that delimit their investigation to a single country or region, allowing for the understanding of cultural, social, and institutional specificities directly linked to the analyzed context (Vooren et al., 2022; Costa et al., 2024; García et al., 2020).

Some identified studies present more than one location or country as reference, characterizing themselves as comparative research. These works stand out by enabling analyses from an international or inter-regional perspective, promoting dialogue between different realities.

The presence of comparative studies highlights the importance of research networks and collaborative publications, which allow transcending territorial, cultural, social, and economic boundaries. Such collaborations strengthen academic exchange, enable the sharing of diversified experiences, and contribute to the consolidation of broader and more integrated scientific partnerships (Vooren et al., 2022).

Table 4 – Locations of Research Data

Countries/Locations	Authors	Number of Publications
USA	Wallwey et al. (2024); Sibia et al. (2020); Womack et al. (2023); Christoph et al. (2021); Zhang et al. (2020); Varol et al. (2021); Morrison et al. (2022); Ying et al. (2021).	8
Brazil	Menolli et al. (2020); Castro et al. (2024); Duran et al. (2023); Klanovicz (2022); Yamashita et al. (2024); Costa et al. (2024a).	6
Spain	Gomez et al. (2022); Hupont et al. (2024).	2
China	Zheng et al.(2024)	1
Saudi Arabia	Rajab et al. (2022).	1
Norway	Lagesen et al. (2021)	1
Australia	Stone. (2021)	1
United Kingdom	Redmond (2022).	1
Finland	Kovaleva et al. (2024).	1
Ethiopia	Melak et al. (2021).	1
Germany	Mattauch et al. (2020).	1
Multiple Countries or Locations	**Authors**	**Total**
Brazil and Spain	García et al. (2020).	1
Brazil and Portugal	Costa et al. (2024b).	1
Netherlands: Holland, Curaçao, Aruba, and Sint Maarten	Vooren et al. (2022).	1
Total Publications		27

Source: Prepared by the authors, 2025.

The Table 4 above presents the concentration of studies conducted in the United States, a pattern already identified by Mattauch et al. (2020), who analyzed gender distribution among authors publishing in conferences in the fields of Computing and Electrical Engineering. The results of that study confirm a pronounced gender disparity in the publications of these areas; however, the numerical data are imprecise, as the authors' gender is not identified in publication profiles or databases, and the NamSor software used in Mattauch et al. (2020) research is not infallible in determining gender based on names.

Regarding the studies conducted in Brazil, it is possible to observe the increasing number of researchers publishing on gender disparity in STEM. These works contribute a significant volume of information and recommendations, which will be discussed throughout this study (Menolli et al., 2020; Castro et al., 2024; Duran et al., 2023; Klanovicz, 2022; Yamashita et al., 2024; Costa et al., 2024).

3.2 Categorization – SLR

Among the 27 articles selected for this study, an evaluation was conducted in which the topics were categorized into three subthemes after reading, annotating, analyzing, and synthesizing the texts. The subthemes were created to address the research question and identify the convergences present in the selected studies.

Thus, to categorize the topics addressed, they were organized and further discussed in the following sections of this publication, distributed according to the following factors:

1. Motivating factors for women's entry/access to STEM courses, with a focus on Computing;
2. Barriers to supporting female students' persistence in STEM courses, with a focus on Computing; and
3. Policies/initiatives aimed at promoting women's entry/access and retention in STEM courses, with a focus on Computing.

3.2.1 Motivating Factors

The motivating factors related to women's entry and access to STEM courses, particularly in Computing, constitute fundamental elements for guiding governmental and institutional policy development.

Additionally, identifying these factors contributes to dismantling social prejudices that still restrict women's participation in certain fields of knowledge. In this sense, it becomes essential for society at large to understand these aspects in order to design encouragement strategies that can effectively promote gender equity in academic and professional spaces.

This perspective is reinforced by the United Nations (UN, 2015) when establishing the 17 Sustainable Development Goals (SDGs), among which the promotion of gender equality and equitable access to education and professional opportunities stands out.

Although studies on dropout in STEM courses are essential, as they help explain the reasons that lead students to abandon these paths, in this analysis the

focus is directed toward the aspects that encourage women to enter and remain in these programs.

Thus, identifying motivating factors not only broadens the understanding of women's academic choices but also provides support for the development of strategies that foster their continuity in Computing and other STEM-related fields.

Table 5 below lists the most frequently cited motivating factors identified by the authors in their publications and selected during the SLR, as follows:

Table 5 – Motivating Factors for Women's Entry into STEM Courses

Motivating Factors for Entry into STEM Courses	**Dimension**	**Authors**
Interest and personal development, as well as previous experiences related to computing.	Personal	Gomez et al., 2022; Redmond, 2022.
Employment prospects, career counseling.	Social	Gomez et al., 2022; Redmond, 2022.
Previous experiences related to computing and STEM during basic schooling.	Institutional	Gomez et al., 2022; Redmond, 2022; Costa et al., 2024 (a).
Social influences: parents, family members, and/or friends working in STEM careers.	Social	Gomez et al., 2022; García et al., 2020; Costa et al., 2024 (a); Melak et al., 2021.
General interest in computing, motivated by games and activities in a computational environment.	Personal	Redmond, 2022; Costa et al., 2024 (a).
Satisfactory academic performance in Mathematics and Science areas, encouraging entry into STEM courses.	Institutional	Vooren et al., 2022; Melak et al., 2021.
Knowledge of professional women who are role models.	Institutional/Social	Melak et al., 2021; Klanovicz, 2022; Mattauch et al., 2022; Costa et al., 2024 (a).

Source: Prepared by the authors, 2025.

Of the 27 articles analyzed, 8 studies discuss the motivating factors for women's entry into STEM courses. These factors can be classified into three main dimensions: 1 – Personal – internal factors, constituted by students' individual experiences and personal interests; 2 – Social (community) – factors influenced by the social and community context in which students are inserted; and 3 – Institutional (school, university, etc.) – intentional factors promoted by educational institutions, aimed at bringing female students closer to scientific knowledge and professional opportunities in STEM.

In this sense, the fundamental role of schools in promoting female students' engagement with scientific knowledge stands out, functioning as spaces of opportunity, support, and critical formation (Maciano et al., 2023).

Attributing gender disparity in STEM exclusively to a matter of women's "personal choice" constitutes a form of denial of structural gender-related barriers. Such barriers, although often rendered invisible, are concrete and directly impact women's academic and professional trajectories.

3.2.2 Barriers

When analyzing these obstacles, it is observed that the difficulty of persistence in STEM courses is associated, among other factors, with the scarcity of consistent institutional initiatives, the absence of specific policies that strengthen female representation in strategic careers, and the maintenance of patriarchal ideologies, which still impose restrictive social roles for women (Botelho, 2022).

In reviewing the publications, it was possible to verify that most authors mentioned barriers to student persistence as a major risk factor for dropout. As mentioned in section 3.2 of this chapter, which details the profile of the studies, we found that the majority – 66.6% of the studies – employ a qualitative approach using diverse instruments (questionnaires, interviews, documentary analysis, etc.); however, the questionnaire prevails as a means of giving voice to a larger number of students.

Table 6 – Barriers for Women's Retention in STEM Courses

Barriers for Women's Student Retention	Authors
Lack of mentoring by female professors and lack of role models.	Wallwey et al., 2024; Rajab et al., 2022; Lagesen et al., 2021; Stone, 2021; Zhang et al., 2020; Kovaleva et al., 2024.
Lack of teacher and student engagement to overcome learning barriers in computing.	Rajab et al., 2022.
Lack of sense of belonging that students may experience when participating in classes with pronounced gender disparity.	Wallwey et al., 2024; Sibia et al., 2020; Christoph et al., 2021; Ying et al., 2021; Klanovicz, 2022; Mattauch et al., 2022; Duran et al., 2023.
Self-efficacy, uncertainties about one's own abilities and capacities to achieve academic objectives, experienced by women in STEM.	Sibia et al., 2020; Zheng et al., 2024; Duran et al., 2023.
Lack of previous experience brings a deficit of prior knowledge that can result in learning difficulties/difficulties with algorithms.	Sibia et al., 2020; Zheng et al., 2024; Womack et al., 2023; Stone, 2021; Zhang et al., 2020; Ying et al., 2021; Duran et al., 2023.
Lack of student financial support: housing, transportation, and food, is a recurring cause of dropout.	Womack et al., 2023; Varol et al., 2021; Duran et al., 2023; Yamashita et al., 2024.
Lack of institutional support with affirmative policies for women's retention in STEM.	Kovaleva et al., 2024.
Lack of diversity causes social isolation/gender balance = lower dropout among men. Studies on the "leaky pipeline" in STEM.	Menolli et al., 2020; Lagesen et al., 2021; Klanovicz, 2022; Mattauch et al., 2020; Duran et al., 2023; Hupont et al., 2024.
Gender stereotypes in STEM and in Computer Science courses.	Lagesen et al., 2021; Kovaleva et al., 2024; Costa et al., 2024; Klanovicz, 2022; Mattauch et al., 2020.

Sexism and discrimination are barriers to student retention in Computer Science. Underrepresentation due to lack of parity and female leadership can cause dropout.	Yamashita et al., 2024.

Source: Prepared by the authors, 2025.

In Table 6, it is possible to infer that most barriers are rooted in the social and institutional dimensions, and in this sense, this research can contribute with data that inspire policies and institutional initiatives, which motivate extension projects for the female audience and raise society's awareness about the issue of gender disparity in STEM courses. Below, Table 7 organizes data on barriers across the Social, Institutional, and Personal dimensions, as a way to visualize that if there is a barrier (threat), it constitutes an opportunity for institutional actions and policies to overcome it, as follows:

Table 7 – Barriers for Women's Retention – Categorized by Dimension: Social, Institutional, and Personal

Social	Institutional	Personal
Lack of diversity causes social isolation/gender balance = lower dropout among men. Studies on the "leaky pipeline" in STEM.	Lack of mentoring by female professors and lack of role models.	Lack of sense of belonging that students may experience when participating in classes with pronounced gender disparity.
Gender stereotypes in STEM and in Computer Science courses.	Lack of teacher and student engagement.	Self-efficacy, uncertainties about one's own abilities and capacities.
Sexism and discrimination are barriers.	Lack of previous experience brings a deficit of prior knowledge.	
Underrepresentation due to lack of parity and female leadership can cause dropout.	Lack of student financial support: housing, transportation, and food.	
	Lack of institutional support with affirmative policies for women's retention in STEM.	

Source: Prepared by the authors, 2025.

Public authorities, educational institutions, and society, in an articulated manner, need to organize specific affirmative initiatives and policies aimed at promoting gender parity in strategic STEM careers. However, the starting point

should focus on academic formation and encouragement of students' academic trajectories, since it is at this moment that the foundations for female students' persistence and development are built.

Table 7 highlights the relevance of the institutional dimension, emphasizing the role of universities and schools in proposing actions capable of minimizing the structural barriers that have historically limited women's entry and persistence in Computing courses and related fields. Regarding underrepresentation, the lack of academic leadership or the invisibility of women's actions in universities is one of the factors that influence women's persistence in STEM courses (Pereira et al., 2023).

3.2.3 Initiatives and Policies

The third category of the SLR studies analysis was created to disseminate research on Policies and/or Initiatives to promote women's entry and persistence in STEM courses, with a focus on Computing. In this category, the number of publications decreases significantly, with only 7 studies focusing on the dissemination or evaluation of institutional or governmental initiatives and policies.

The density of studies addresses the barriers and motivating factors for entry and persistence in courses where gender disparity is pronounced, in STEM and especially in Computing courses.

The institutional initiatives identified in the selected studies are: teaching and learning support resources (Yamashita et al., 2024; Costa et al., 2024b); continuing education for faculty (Rajab et al., 2022); courses implemented to overcome academic difficulties (Zhang et al., 2020; Christoph et al., 2021); creation of exclusive female cohorts in higher education (CS1) (Ying et al., 2021); surveys of initiatives and policies to encourage women's entry and persistence in STEM (Costa et al., 2024a); and initiatives for welcoming students entering STEM higher education courses (Lagesen et al., 2021).

Table 8 – Initiatives and Policies in STEM Courses

Initiatives/Policies in STEM Courses	Authors
Teacher training aimed at improving student retention and academic outcomes.	Rajab et al., 2022.
Student welcoming initiative in universities: *The Women and Computing Initiative* (WCI).	Lagesen et al., 2021.
Basic Knowledge Courses to overcome academic learning difficulties.	Zhang et al., 2020; Christoph et al., 2021.
Studies on initiatives, programs, and projects to encourage women's entry and retention in STEM courses.	Costa et al., 2024a.
Validation of the project *Heroine's Learning Journey*, through a game designed to motivate women to enter STEM.	Costa et al., 2024b.
Creation of women-only classes in the course *Computer Science 1 (CS1)*.	Ying et al., 2021.
Teaching resources to support the retention of women in STEM programs.	Yamashita et al., 2024.

Source: Prepared by the authors, 2025.

A plurality of actions designed to overcome the barriers identified in different initiatives implemented in distinct national contexts is observed. The systematization and dissemination of these studies prove to be fundamental for deepening the understanding of the global scenario regarding the limited entry of women into courses, as well as in relation to the so-called leaky pipeline, resulting from high rates of female student dropout.

The study by Costa et al. (2024a), titled "Women's Journey in STEM Education in Brazil: A Rapid Review on Engineering and Computer Science," aimed to identify barriers, motivating factors, and strategies reported in Brazilian academic literature in the context of female participation in Engineering and Computer Science courses. In this study, the authors highlight successful initiatives

in Brazil: "Programa Cunhantã Digital," "Projeto Meninas na Ciência"(Girls in Science Projects), and "Programa Meninas Digitais"(Digital Girls Program), (Maciel, 2018). It is highly significant that these programs become widely disseminated, as they aim to motivate women's entry into STEM and support the academic trajectory of female students entering these courses.

An innovative initiative described by researcher Ying et al. (2021) reports the implementation of a differentiated proposal at a North American university, aimed at introductory Computer Science (CS1) instruction, a fundamental course at the beginning of university studies. The intervention consisted of offering an alternative, small-sized class composed exclusively of female students (35 students), parallel to the traditional mixed class (with 601 students, of whom 149 were women). The results indicated that students in the all-female class reported significantly higher levels of social connections and greater comfort when interacting with peers, compared to women in the mixed class, according to Ying et al. (2021).

There are concerns about isolating women in classes to generate a sense of belonging and comfort during academic formation, but segregation can be interpreted as prejudice. Countries such as Saudi Arabia, where classes are separated and exclusively female or male, also face challenges regarding gender disparity, as evidenced by studies by Rajab et al. (2022). Segregation can reinforce gender stereotypes, suggesting that women cannot compete or learn on equal terms with men.

As the local experiences presented in the SLR studies are proposals to overcome barriers and promote female students' motivation for choosing and persisting in STEM courses, all initiatives and policies were preceded by local data collection that differs and cannot be generalized. Institutions, governments, and society need to observe policies already proposed; however, data on local entry and persistence are important subsidies for generating initiatives more responsive to reality.

4. Final considerations

The systematic literature review conducted in this study made it possible to understand, in an integrated manner, some of the factors that influence women's entry and persistence in higher education Computing courses, as well as the barriers and institutional initiatives that shape this scenario. The analysis of 27 national and international publications produced between 2020 and 2024 enabled the identification of a consistent set of evidence that addresses the research questions and reflects diverse realities, though intersected by similar patterns of inequality.

Regarding the first question — which policies and initiatives promote women's persistence in higher education STEM courses, with a focus on Computing — the findings indicate a low incidence of structured, continuous, and institutionalized actions. Among the identified initiatives, welcoming programs, mentoring actions, exclusive female cohorts in introductory courses, didactic resources aimed at engaging women, and faculty development projects stand out. Although relevant, such initiatives remain dispersed, sporadic, and poorly systematized, which highlights the need for more robust, comprehensive, and locally-informed public and institutional policies.

As for the second question — which factors motivate these students' entry and/or persistence — it was observed that motivations emerge from three dimensions: personal, social, and institutional. Prior interest in Computing, positive experiences in STEM/STEAM activities in basic education, performance in Science and Mathematics, family influence, female role models, and early contact with technologies constitute central elements for stimulating entry. However, such factors do not, by themselves, guarantee persistence if they are not associated with welcoming academic environments, support networks, and pedagogical practices sensitive to gender inequalities.

In answering the third question — which gender barriers persist in higher education Computing — the study revealed that the main obstacles faced by female students concentrate in the social and institutional dimensions. Feelings of non-belonging, isolation, low female representation among faculty and mentors, gender

stereotypes, veiled or explicit discrimination, deficit in self-efficacy, absence of affirmative policies, and socioeconomic vulnerabilities emerge recurrently. These elements, when accumulated, intensify the leaky pipeline phenomenon, limiting female presence throughout academic and professional trajectories.

The results of this systematic review reaffirm that gender inequality in Computing does not stem from individual factors, but from structural and social conditions that shape women's formation from basic education onward. Addressing this scenario requires integrated, continuous, and articulated policies among educational institutions, public authorities and society, in order to promote more equitable, diverse, and inclusive environments. The strengthening of institutional initiatives, the expansion of support networks, and the consolidation of pedagogical practices committed to equity constitute indispensable paths for reducing inequalities and fostering social justice in Computing courses.

In summary, priorities for future research concentrate on: (1) longitudinal studies that follow women's trajectories in STEM; (2) rigorous evaluations of institutional policies and initiatives; (3) expansion of research in Brazilian and developing country contexts; (4) analyses of intersectionality and complex structural barriers. By gathering and critically analyzing recent evidence, this study contributes to the field by offering an updated panorama of gender inequalities in Computing and by pointing to concrete paths for policy formulation and new research agendas, always recommending local diagnostic surveys for the implementation of policies promoting student entry and persistence.

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