First steps towards gender equity in engineering at Universidad EAFIT in Colombia

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Abstract

Global statistics point to a decreasing presence of women in certain Engineering areas, a trend also evident at Universidad EAFIT. The objective of this work is to present the initial steps taken by the authors towards gender equity in Engineering at this university. To achieve this, an exploratory analysis of gender indicators was conducted, and actions were presented for and with four different audiences: children and teenagers outside the university, professors within the university, students outside the classroom, and students inside the classroom. The results show a relative decrease in female faculty and students, as well as horizontal segregation among different Engineering areas. Regarding strategies outside the university, female faculty and engineering students visit urban and rural schools to conduct programming and science workshops. Additionally, as Engineering female faculty, we are part of interinstitutional networks and communities for gender equity. Within the university, the student research seedbed executes a project called "Perceptions of Gender Equality, Inclusion, and Leadership in Systems Engineering Students" since 2020. Lastly, within the classroom, a strategy was designed to teach and assess the national and international contributions of women to Systems Engineering. The results obtained highlight the need to develop gender projects and studies that reduce inequalities in academic spaces and contribute to motivation and guidance in decision-making, both in policy and academic-formative aspects, to advance towards gender equality, leadership, and inclusion in university.

Keywords

Indicators, gender gap, strategies, attraction, retention, role models

1. Introduction

The School of Applied Sciences and Engineering at Universidad EAFIT has been a member of the Latin American Open Chair (CAL) Matilda and Women in Engineering since 2020, aiming to promote equity, equal rights, opportunities, and spaces for women in the academic and professional sphere. One of the initial actions of CAL Matilda was to construct a methodology for diagnosing the gender gap in Systems Engineering faculties at Latin American institutions.

Within the School, initiatives have been underway to reduce the gender gap, starting with the attraction of girls and young women and extending to the retention of current female students, faculty, and researchers. Since 2021, the Software Engineering Research Seedbed has been conducting a study to determine students' perceptions regarding gender in relation to equality, leadership, and inclusion in various academic activities within the Software Engineering program. This project aims to be replicated

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in other programs. To carry out the proposed project, an action research method with multiple linear cycles, content validation through expert judgment, and a pilot test are employed. Methodologically, this proposal involves five research cycles: conceptual analysis, instrument construction based on identified related works, instrument application, and, finally, result analysis and dissemination.

In addition to this initiative, as a strategy to challenge stereotypes in the field, female role models in Systems Engineering at Universidad EAFIT have been made visible. In the "Data Structures and Algorithms 1" courses, a pedagogical strategy has been designed to teach and assess the contributions of women to Systems Engineering, both at the national and international levels. This initiative is supported by literature demonstrating that female role models have a more significant impact on retaining students who are already enrolled in the Systems Engineering program rather than on recruitment. The pedagogical strategy was tested during the second semester of 2020 and the first semester of 2021.

In the remainder of this article, we will present the indicators we have developed for diagnosing the school's gender dynamics. Subsequently, we will describe how we designed a pedagogical proposal to highlight the contributions of female computer scientists, both nationally and internationally. Then, we will introduce other strategies beyond the classroom, including research seedbeds, reflection workshops, and school visits. Finally, we will conclude with a section outlining the next steps in consolidating these strategies.

2. Theoretical Framework and Related Works

Addressing gender equity should be a topic included in the agendas of higher education, particularly in engineering programs. Despite advances in the inclusion of women in higher education and the workforce, the representation of women in engineering remains low in many countries. The lack of gender equity in engineering programs can limit innovation, progress, and contribute to the gender gap in economic opportunities. In 2022, UNESCO and Times Higher Education [3] revealed the extent to which higher education institutions worldwide contribute to gender equality. They examined the contribution to gender equality made by a range of higher education institutions around the world using 18 different indicators and highlighted case studies of five universities leading this effort in their regions. In the W-STEM program, García-Holgado et al. [4] describe a methodological proposal for analyzing gender equality in STEM-related academic programs and apply it to 10 universities. The results identify existing gender disparities in the analyzed academic programs, including unequal representation of men and women in different fields and educational levels. Lastly, a policy and practice analysis sheds light on possible obstacles or barriers contributing to the gender gap in the field of study. The proposal suggests developing specific strategies to enhance equal opportunities and reduce gender disparities in the analyzed programs, contributing to a more inclusive and equitable university environment.

Among the 776 institutions evaluated [3], 54% of globally graduated first-cycle students are women. However, only 30% of women study STEM (Science, Technology, Engineering, and Mathematics) subjects, compared to 54% studying programs in the social sciences, indicating a clear horizontal segregation.

Specifically, in Systems Engineering, the participation of women is very low. According to the U.S. Department of Education's 2023 Education Statistics Summary [5], the percentage of women choosing a Systems Engineering career was 14% in 1970-1971. This percentage increased to 37% between 1983 and 1984 but gradually decreased to 21% between 2018 and 2019. Burger et al. [6] agree that gender gaps in technology programs have increased. In Colombia, the situation is no different; in 2019, only 17.2% of enrolled Systems Engineering students were women.

There are initiatives that promote gender equity in the field of engineering. Mody and Brainard [7] present proposals and their results with the aim of understanding the key factors contributing to gender disparities in engineering. As a literature review, this work focuses on understanding the strategies, programs, and policies associated with unequal participation and representation of women in engineering. The main results highlight strategies in the following dimensions: (i) awareness and training, such as addressing biases and stereotypes to eliminate cultural barriers; (ii) access to opportunities and resources; (iii) leadership and commitment, where institutions take a proactive role in equity; (iv) measurement and monitoring, demonstrating that successful initiatives result from tracking and evaluation to measure progress. Analyzing changes over time in predictors of the intention to study Systems Engineering, elements like a scientific orientation have gained strength over the last 40 years, while variables like artistic orientation and self-perceived mathematical ability have decreased in importance [8]. This is positive, as it indicates that the barrier of self-perceived mathematical ability is weakening, and women who consider themselves more creative and artistic are showing interest in this field.

In addition to the explored variables, external factors such as the stereotype of the Systems Engineering field and computer scientists are also considered as deterrents for women [8]. Women perceive Systems Engineering as an individualistic field that does not emphasize social impact [6]. Some studies demonstrate gender biases and stereotypes in education and engineering careers [1], which can affect women's selection and success in these programs [9]. For example, gender stereotypes can influence career choice, the valuation of women's contributions in the classroom and the workplace and mentoring and tutoring opportunities. The experiment conducted by Chervan et al. [10] illustrates how a two-minute exposure to a person fitting the computer scientist stereotype can have a negative impact on women's interest in this career for up to two weeks after the encounter.

As strategies to attract women to science and engineering areas, the presence of role models in the family and at school, such as teachers and career advisors, is highlighted [11]. However, three recent studies have demonstrated the greater effectiveness of the strategy when exposure is brief [12] [13]. The large-scale random experiment conducted by some researchers analyzed the effect of a one-hour in-class exposure to a female scientist on tenth and twelfth-grade students [14]. Fifty-six female scientists interacted with approximately twenty thousand students. The study demonstrated that exposure can improve students' perceptions of scientific careers and increase women's participation in STEM fields in college. Other studies emphasized that the most significant effect was observed in twelfth-grade girls, as they were more receptive than other student groups to the appealing image of science-related careers embodied by role models, and their aspirations for such careers increased substantially [15]. The strategy's efficiency depended on the scientist's profile, related to her professional experience, position in her career, and compensation. They also highlighted that emphasizing gender equity too much could be counterproductive, and gender-neutral messages might be more effective in guiding girls towards STEM fields.

Bilimoria and Liang [16] evaluate the NSF ADVANCE initiative at 19 U.S. universities, highlighting increased gender participation and equity in fields such as engineering and sciences, and providing an organizational change framework. Continuing with strategies to promote gender equity in higher education and engineering programs, Fruttero et al. propose the creation of support networks for female students and professionals, the revision and updating of curricula to include a gender perspective, and the promotion of diversity in student selection and hiring [15]. Harris et al. present results from a pilot qualitative study in the Department of Industrial Engineering at the University of Oklahoma (USA), where gender parity has been achieved in both students and faculty. They identify factors for achieving this in engineering and sciences, such as a supportive environment, extracurricular activities like study groups and research seedbeds, and mentoring [6], [17].

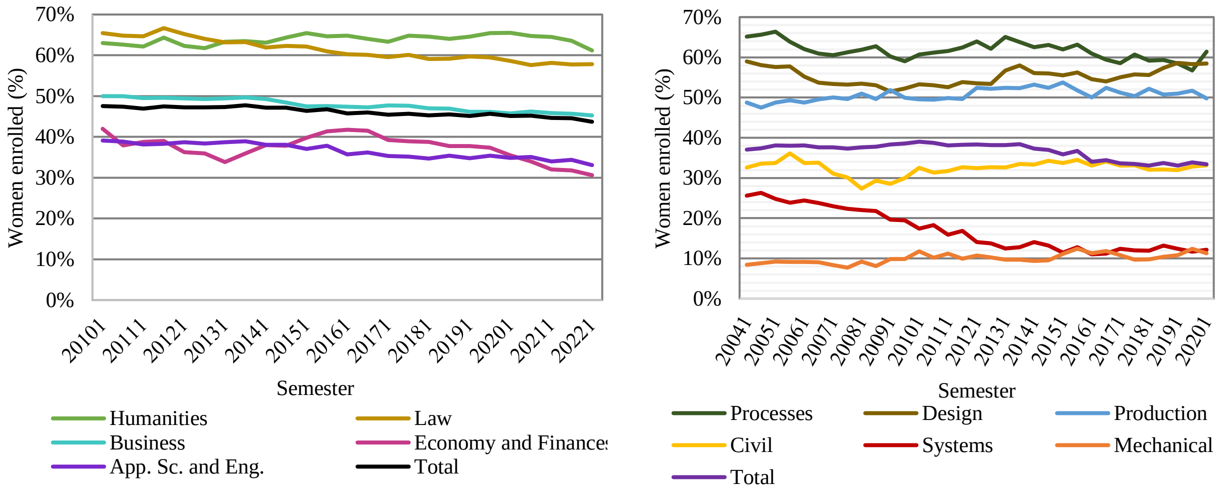
Gender equity in education and engineering programs not only brings benefits for women but can also enhance innovation, creativity, and the quality of education [18]. Including a gender perspective can improve engineers' sensitivity and empathy in decision-making and problem-solving. Additionally, quantifying the gender gap and identifying gender bias in engineering programs will allow the measurement of the effectiveness of implementing strategies to promote gender equity. Awareness of the benefits of gender equity is critical for achieving gender equality in education and engineering programs.

On the other hand, organizational culture and climate can influence gender equity in engineering programs. Powell et al. [19] focus on examining how female engineers face, negotiate, challenge, and even resist gender expectations in their profession and how this impacts gender equality in engineering. In other words, the study explores how female engineers navigate gender norms and how these strategies affect their progress and opportunities in the industry. Qualitative research is used, involving interviews with female engineers at different stages of their careers. These interviews focus on exploring participants' personal experiences related to gender expectations in engineering and the strategies they use to confront or challenge those norms. As a result, adaptation strategies to be accepted and respected, and to fit into male-dominated environments, are revealed. Among the challenges in combating gender discrimination, the work demonstrates how these women seek to change the perceptions and expectations they face in these environments, and even how they face obstacles in their professional advancement. The study suggests that female engineers, by adapting to male cultures in engineering, can perpetuate a hostile.

3. Quantitative Gender Gap Indicators

Universidad EAFIT used to have an open data portal until 2021 (https://www.eafit.edu.co/eafitencifras). Most of the data used for the construction of the quantitative gender gap indicators presented in this section was extracted from this portal. At Universidad EAFIT, the proportion of women relative to the total undergraduate student population in the university has decreased over the past ten years, as shown in Figure 1. When considering all programs, the participation of women decreased from 48% in 2010-1 (i.e., the first semester of 2010) to 44% in 2022-1. Focusing on the School of Applied Sciences and Engineering, the scenario is discouraging, decreasing from 39% to 33%.

Currently, at Universidad EAFIT, as evidenced by global trends, there is horizontal segregation. As shown in Figure 1, the proportion of women in the undergraduate student population varies significantly between schools. So, even though women represent 44% for the semester 2022-1 in the total university, they make up 61% in the School of Humanities, 33% in the School of Applied Sciences and Engineering, and 31% in the School of Economics and Finance. Furthermore, in the last 10 years, most schools have seen a gradual decrease in the percentage of women's participation. Although this decline may be slight (between 4 and 11%), it is generally consistent, with the exception of fluctuations observed in the School of Economics and Finance, related to the smaller number of students compared to other schools.



(a) (b)

Figure 1 Proportion of women in the total undergraduate student enrollment per semester, both (a) by School and (b) by Program in the School of Applied Sciences and Engineering.

Furthermore, within the School of Applied Sciences and Engineering, a breakdown of the proportion of women by academic programs (see Figure 1b) reveals that in fields like Process Engineering (similar to Chemical Engineering in other institutions) and Product Design Engineering, the representation of women ranges from 65% to 55%. However, in programs like Civil Engineering, Systems Engineering, and Mechanical Engineering, the percentage of women falls well below 50%. Notably, there has been a significant decline in female enrollment in the Systems Engineering program, with women dropping from 26% in 2004-1 to just 13% in 2021-1.

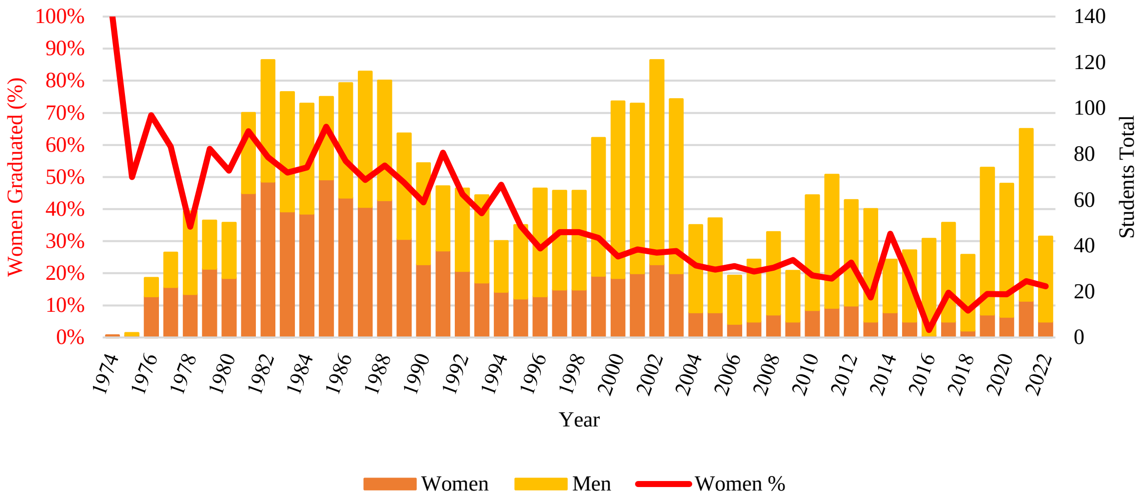


Figure 2 Historical Record of the Proportion of Female Graduates in Systems Engineering.

In fact, over the course of the 48 years since the inception of the Systems Engineering program at Universidad EAFIT, the proportion of women in the graduating population has significantly decreased, as illustrated in Figure 2 (see the red line with its values on the left). The first person to graduate from the program was a woman. In the early years, while the total number of graduates was increasing (see the bars in the same Figure and their values on the right), the percentage of women decreased slightly but remained above 50% until 1987. From that point onwards, not only did the number of women decrease, but the number of men increased, further accentuating the decline in female participation among program graduates.

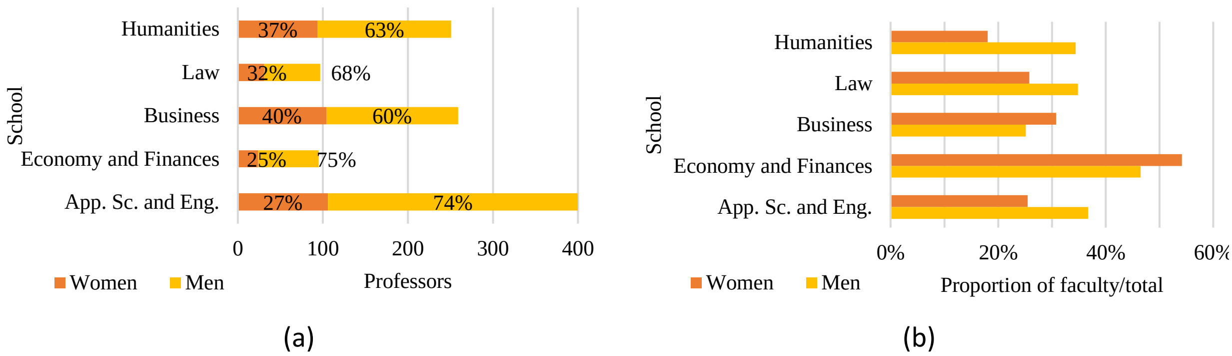


Figure 3 Professors by School for the 2020-2 semester and (a) their gender ratio and (b) according to the proportion of faculty (i.e. full-time and indefinite-term contract) of all professors.

Another significant indicator in the gender gap in academia is in professors. As shown in Figure 3a, while the number of professors in each school varies greatly, the female professors are below 40% for all schools and drops to 25 and 27 % for Economy and Finances and Applied Sciences and Engineering, respectively. The separation between faculty or full-time professors, who have indefinite contracts and follow the academic ranking, and adjunct professors, who have semester-based contracts and do not have an academic ranking is shown in Figure 3b segmented by gender. In this figure, we can observe that in the Schools of Business Administration and Economy and Finances, the proportion of women that have a full-time contract is higher than that of male professors. Conversely, in the Schools of Law, Humanities, and Applied Sciences and Engineering, this ratio is reversed. The proportion of full-time professors concerning the total number of professors depends on various internal factors and policies within each school and program; however, we can discern marked differences in this proportion when separated by gender. Particularly in the School of Applied Sciences and Engineering, 25% of female professors are full-time, while for male professors, it is 37%. This results in only 20% of female full-time professors in the school, the lowest proportion among all the schools. In the Department of Systems Engineering, similar gender distribution percentages are observed among full-time professors, with 30% being women.

Lastly, we analyzed the population of researchers according to the current classification from the Ministry of Science and Research in Colombia, MinCiencias (2021). As shown in Figure 4a, considering all types of researchers (students, part-time, full-time professors) segregated by gender and school, we find that, except for the School of Business Administration which achieves almost a 50-50 balance, the other schools have a female participation in research at around 27%, a figure that is reflected in the previously presented indicators, but it is slightly higher than for professors.

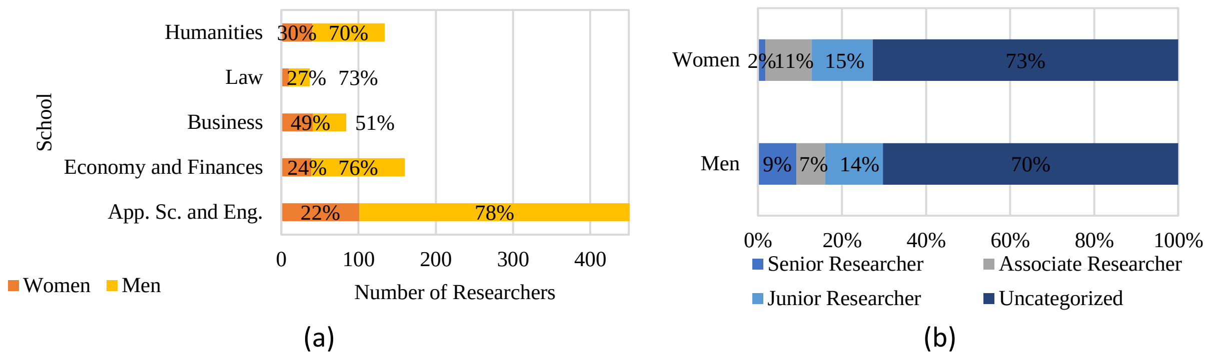


Figure 4 Researchers from Universidad EAFIT according to the Minciencias 2019 call, separated (a) by School in total number and gender ratio, and (b) by category, separated by gender.

However, the distribution of each gender in different categories varies significantly. In the Colombian research system, there are three categories: Senior, Associate, and Junior, along with a fourth option (uncategorized) for individuals who are not active in research or have not participated in the call. Figure 4b presents the proportion of researchers segmented by category and gender. Among male researchers, 70% are not categorized, while 9% are in the highest category (Senior Researcher). In contrast, among female researchers, 73% are not categorized, and only 2% hold the title of Senior Researcher. Therefore, while the proportion of women in the uncategorized researcher population is 30%, like the previous indicators, the proportion of women in the Senior Researcher category drops to 8%. In the remaining categories, the values invert slightly, as 31% of Junior Researchers are women, and 40% of Associate Researchers are women. This clearly indicates a vertical gender gap in research, like the commonly used "glass ceiling" term concerning the gender gap in higher positions in other professional fields.

The presented indicators highlight the gender gaps in research, teaching, and the student population. Measuring these indicators is crucial to quantify differences and their evolution over time. However, it is not sufficient. Building a gender gap diagnosis should include qualitative aspects to understand the institution's climate regarding this situation and enable the development of a comprehensive policy defining specific goals and actions. This process is being carried out by the university's Gender Committee. Simultaneously, both inside and outside the university, we have implemented innovative actions that contribute to gender equity among researchers, professors, and students.

4. Strategies at Universidad EAFIT for Gender Equity

As part of the commitment to gender equity within the institution, various strategies have been implemented and can be grouped into four categories. In the remainder of this section, representative cases for each category will be presented. For each strategy, there is a stated purpose, a brief description of the activity along with the actions taken, and finally, some actions planned to continue each strategy.

4.1. Interinstitutional Strategies in Primary and Secondary Education

With the assistance of student research seedbed at the University, it has been possible to make an impact on girls living in rural areas and show them that the path to improving their quality of life and that of their families is through higher education, as seen in the photographs in Figure 5. Regularly, visits to schools are organized with the purpose of teaching basic concepts of computer science. It is worth highlighting that these visits are organized by female professors, and in the student research groups, both male and female students, as well as boys and girls, participate. Thus, even though these activities may not have a gender-specific focus, the construction of role models through personal example is implicit in each visit.

Figure 5 Visits to schools and engineering workshops led by female professors and female students.

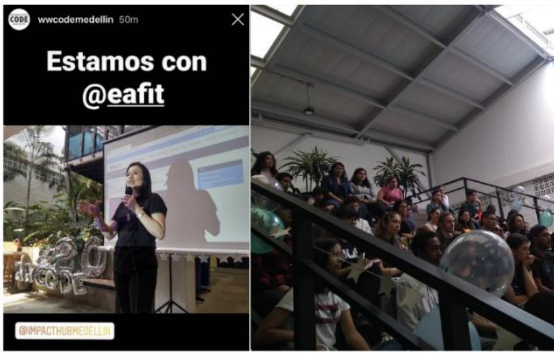
4.2. Interinstitutional strategies for other stakeholder groups

The main objective of these strategies is to create a space where women can connect, share experiences, and learn new skills in a safe and respectful environment. In this context, according to a study by the technology company Dell, women who participate in technology-related activities are more likely to feel empowered and have a successful career in the field. Furthermore, a study by the Pew Research Center found that women with experience in technology activities are more likely to consider a career in technology and feel comfortable in a tech-related environment. Therefore, women in technology communities are essential initiatives in which our university has also invested to promote gender equality and diversity in the tech sector.

In the city of Medellin, activities for women in technology communities have been developed to promote inclusion, participation, and empowerment of women in the technology industry, which, as already evidenced, has been male-dominated. According to McKinsey, in the tech industry, women only occupy 20% of technical roles and just 5% of tech leadership positions. This gender imbalance can lead to issues related to diversity, inclusion, and productivity in tech companies, and it can even result in biases in the technologies developed due to the limited participation of women in their creation.

To address this gender gap, various organizations worldwide and specifically in the city of Medellin have created initiatives to engage women in technology, such as Girls Who Code, Women Who Code, Pioneras Dev, Data Science Fem, among others. Globally, the National Center for Women & Information Technology (NCWIT) is recognized for its inclusive tech initiative. In this context, Universidad EAFIT has worked closely with communities like Women Who Code, Pioneras Dev, and Data Science Fem. The activities of these communities include hackathons, workshops, training courses, conferences, and inspirational talks, as shown in Figure 6.

a. CodeBreakers doing programming



b. Women who code first meeting at Medellín

c. Data Science Female Course

d. Django Girls doing a programming course

Figure 6 Interinstitutional strategies for other stakeholder groups.

Figure 6a shows the Codebreakers event organized by TechGirlz to set a world record for the number of girls coding simultaneously. On that day, two records were set: i) The highest number of girls coding simultaneously in one location, and ii) the highest number of girls coding simultaneously at multiple locations. It's worth noting that TechGirlz is a non-governmental organization in the United States focused on helping girls in schools explore careers in technology. The idea is for participating girls to share their curriculum with companies, organizations, schools, and community groups to inspire other girls worldwide with technology.

On the other hand, Figure 6b shows the launch of the Women Who Code chapter for Medellín. This community is an international nonprofit organization with the goal of providing opportunities for women to excel in technology and programming careers by creating a community and a job board.

In Figure 6c, there is a Data Science Fem course for systems students and the community in general on topics related to data science. Data Science Fem is a Spanish-speaking Latin American community focused on promoting knowledge of data science among women in the region. They also offer scholarships and technical education programs.

Finally, in Figure 6d, there is a programming course with the Django Girls community, a nonprofit organization that seeks to empower and assist women by offering programming courses in a volunteer-based scheme. This community is run by hundreds of volunteers who contribute to bringing more amazing women into the world of technology. They are making technology more accessible by creating resources designed with empathy.

Participation in internal and external networks at the university by employees (faculty and staff).

CAL Matilda, since July 2020: The University EAFIT is an institutional member of the Latin American Open Chair of Matilda and Women in Engineering from CONFEDI (Federal Council of Deans of Engineering of the Argentine Republic), ACOFI (Colombian Association of Engineering Faculties), and LACCEI (Latin American and Caribbean Consortium of Engineering Institutions). This membership has been in place since July 20, 2020, with Silvana Montoya as the institutional representative and Elizabeth Suescún as the substitute. Additionally, Professor Liliana González from the Systems Engineering department recently joined as an individual member. Professor Silvana Montoya is a part of the Education Committee and coordinates the Research Committee.

Gender Roundtable at EAFIT, since February 2021: A gender roundtable was formed within the University EAFIT to unite all stakeholders contributing to gender equality, including the Center for Integrity, the Center for Political Analysis, the Employee Development Office, the research seedbed Women and Law, the seedbed on perception of equality, leadership, and gender inclusion, "En Femenino," Matilda, and the University of Children. This roundtable meets weekly or biweekly and is currently working on developing a methodology for conducting an institutional gender equality assessment.

Matilda EAFIT, since 2020, EAFIT Engineering Professors: A discussion group on gender equality in EAFIT Engineering was formed. Its members engage in individual activities on the topic, which are shared in this space. For example, Mauricio Toro, a professor of Systems Engineering, published an article on "Good Practices in the Classroom" presented at ACOFI EIEI 2021. Additionally, a thematic coffee session with EXA was organized for EAFIT professors on December 10, 2020, titled "How do we promote gender equality in the classroom?"

The group has also participated in books from the Matilda Chair, which provide anecdotal accounts of how women enter the field of engineering and choose their niches of action. This is an additional way to provide examples for girls and women to follow if they consider STEM areas their passion.

4.3. Institutional Strategies Outside the Classroom

The purpose of these strategies is to highlight gender gaps and raise awareness within the institutional community about the need for a gender perspective to promote a more inclusive culture in institutions. To date, three seminars and two workshops have been held. It is worth noting that these activities have been organized by the female authors of this article, on a voluntary basis and with open participation. Therefore, they do not aim to provide gender-related training, courses, lectures, diplomas, or formal training processes for teachers, staff, or students.

4.3.1. Seminars and workshops for awareness-raising

Since 2020, various seminars and events have been conducted on the subject, focusing on professors and students in the field of Engineering. These events are open, and several are available online.

1. Event: "Women at EAFIT: Engineering and Inspiration," May 30, 2019 (in-person): Campus tours and conversations between high school students and researchers from the University.
2. Seminar: "EAFIT's Women in Engineering: Engineering the Gender Gap," discussion and presentation, March 13, 2020 (virtual and in-person): Link
3. Seminar: "Matilda and Women in EAFIT's Engineering: A Brief Look at the Gender Gap," presentation, October 23, 2020 (virtual): Link
4. Discussion: "Sisterhood and Technology: Stories of Leadership and Learning," March 27, 2020 (virtual).
5. Workshop: "How Invisible Are Women in Engineering?" March 9, 2022 (in-person).

The former workshop received support from the student organization of civil engineering and Karen Ortiz, a social worker from the Center for Women in STEM Strengthening at the National University of Colombia. Together, they designed visual materials illustrating how a gender perspective influences everyday scenarios, drawing inspiration from Caroline Criado's book "Invisible Women." Following a brief reflection on gender gaps, students worked in groups to analyze these visuals, answer questions, and express their insights through their own drawings.

4.3.2. **Research as a Gender Equity Strategy Outside the Classroom**

Currently, the Engineering Student Research Group is conducting a project titled "Perception of Equality, Leadership, and Gender Inclusion" in collaboration with the University of Cauca and their counterpart research group. This project focuses on assessing the current perceptions of students enrolled in Systems Engineering programs at both universities regarding equality, inclusion, and gender leadership, with the intention of expanding the study to other programs at both institutions. The execution of this study consists of two phases.

In Phase 1, a literature review was conducted to identify survey-based measurement instruments used in educational institutions to assess dimensions relevant to the study. The initial version of the survey instrument was created, reviewed by experts in the field, refined, and then piloted at both the University of Cauca's Speech Therapy program and EAFIT University's Civil Engineering program. The project is currently in Phase 2, the second year, during which the survey will be administered at both institutions to collect both qualitative and quantitative data.

This study aims to establish the gender perceptions of university students in terms of equality, inclusion, and leadership. It will help identify existing gender disparities within the academic context, and if such disparities are found, the results will highlight the need for gender-focused studies and projects aimed at reducing gender inequality. Furthermore, the outcomes will contribute to decision-making processes, both in terms of policy and academic development, that will enable the university to progress toward gender equality, leadership, and inclusion.

4.4. Institutional strategies within the classroom

The course on Data Structures 1 (semester 2) aims to develop the skill of solving a problem with an algorithm that uses fundamental data structures, calculate the algorithm's complexity, and argue the criteria for selecting a data structure (Link: https://bit.ly/3dBAFsc). This strategy involves introducing women who have made contributions to systems engineering in each class. Some examples of the role models presented in each class are shown in Table 1 (including globally recognized figures like Katie Bouman (Caltech), Marissa Mayer (Yahoo), or Sophie Wilson (Broadcom). Additionally, we introduce highly regarded Colombian women in the IT industry such as María Clara Choucair (Choucair Testing), Ángela Noreña (Google), and Natalia Franco (Rappi). Finally, we present graduates and students who have achieved significant recognition, such as Ana Echavarría (Google) and Luisa Vásquez (Facebook). As an example of this strategy, here is the presentation from the first class of the course (https://bit.ly/30mFhMh).

Table 1 Examples of female role models presented in the course classes.

Lesson	**Role Models Presented**
Abstract Data Types	Katie Bouman, Ada Lovelace, Gayle McDowel, Linus Torvalds, Barbara Liskov, Shigeru Miyamoto, Natalia Ochoa, María C. Choucair, Marissa Meyer.
Recursion	Sophie Wilson, Dorothy Vaugham, Rózsa Péter, Alonzo Church, Alan Turing
Dynamic Lists	Elizabeth Suescún
Stacks and Queues	Paola Vallejo

To assess students' knowledge about the women studied during the course, an exercise was designed for the first midterm with an extra bonus score. The exercise involved matching a column with the names of the women to a column with their contributions to Systems Engineering. This evaluative strategy was implemented in three groups during the second semester of 2020 and in two groups during the first semester of 2021.

5. Conclusions and Perspectives

After presenting gender gap indicators in the student, faculty, and research populations at the University EAFIT (Colombia) and the School of Applied Sciences and Engineering, a set of strategies were introduced to promote gender equity within the school. Various types of activities, both inside and outside the classroom, as well as external actions to the institution, were presented. These efforts aim to measure the overall population's perception and increase the presence of women in STEM fields, a concern not limited to this university but evident at regional, national, and global levels.

To go beyond the recognition of female role models, both within and outside the university, it may be possible to assess the perception of competence in the engineering field based on gender and evaluate systematically the effectiveness indicators of the actions undertaken.

As additional future work, there is the possibility of conducting more in-depth research on the current characteristics of women who decide to pursue engineering and the perceived barriers to choosing this career in the local context. Based on these results, initiatives could be designed to attract women to engineering in the student, faculty, and research populations.

6. References

[1] B. J. Drury, J. O. Siy, y S. Cheryan, «When do female role models benefit women? The importance of differentiating recruitment from retention in STEM», Psychol. Inq., vol. 22, n.o 4, pp. 265-269, 2011.

[2] A. Berrio y S. Perez, «Towards a new concept on engineering education», J. Educ. Technol., vol. 24, n.o 12, pp. 269-286, 2002.

[3] «Gender equality: how global universities are performing, part 1», UNESCO International Institute for Higher Education in Latin America and the Caribbean (IESALC) and Times Higher Education, 1, 2022. [En línea]. Disponible en: https://unesdoc.unesco.org/ark:/48223/pf0000380987

[4] A. Garcia-Holgado et al., «Gender equality in STEM programs: a proposal to analyse the situation of a university about the gender gap», en 2020 IEEE Global Engineering Education Conference (EDUCON), Porto, Portugal: IEEE, abr. 2020, pp. 1824-1830. doi: 10.1109/EDUCON45650.2020.9125326.

[5] National Center for Science and Engineering Statistics, «Diversity and STEM: Women, Minorities, and Persons with Disabilities», NSF 23-315, 2023. [En línea]. Disponible en: https://ncses.nsf.gov/pubs/nsf23315/

[6] C. Burger et al., «Gender equity in science, engineering, and technology», en Handbook for achieving gender equity through education, 2nd ed., Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers, 2007, pp. 255-279.

[7] P. N. Mody y S. G. Brainard, «Successful international initiatives promoting gender equity in engineering», en Proceedings of the international symposium on Women and ICT creating global transformation - CWIT '05, Baltimore, Maryland: ACM Press, 2005, pp. 5-es. doi: 10.1145/1117417.1117422.

[8] L. J. Sax et al., «Anatomy of an enduring gender gap: The evolution of women's participation in computer science», J. High. Educ., vol. 88, n.o 2, pp. 258-293, 2017.

[9] S. J. Ceci y W. M. Williams, «Understanding current causes of women's underrepresentation in science», Proc. Natl. Acad. Sci., vol. 108, n.o 8, pp. 3157-3162, 2011.

[10] S. Cheryan, B. J. Drury, y M. Vichayapai, «Enduring influence of stereotypical computer science role models on women's academic aspirations», Psychol. Women Q., vol. 37, n.o 1, pp. 72-79, 2013.

[11] S. Canaan y P. Mouganie, «The impact of advisor gender on female students' STEM enrollment and persistence», J. Hum. Resour., vol. 58, n.o 2, pp. 593-632, 2023.

[12] C. Porter y D. Serra, «Gender differences in the choice of major: The importance of female role models», Am. Econ. J. Appl. Econ., vol. 12, n.o 3, pp. 226-254, 2020.

[13] L. Del Carpio y M. Guadalupe, «More women in tech? Evidence from a field experiment addressing social identity», Manag. Sci., vol. 68, n.o 5, pp. 3196-3218, 2022.

[14] C. Napp y T. Breda, «The stereotype that girls lack talent: A worldwide investigation», Sci. Adv., vol. 8, n.o 10, p. eabm3689, 2022.
[15] A. Fruttero, N. Muller, y O. Calvo-Gonzalez, «The power and roots of aspirations: A survey of the empirical evidence», 2021.
[16] D. Bilimoria y X. Liang, Gender Equity in Science and Engineering, 0 ed. Routledge, 2012. doi: 10.4324/9780203149133.
[17] B. J. Harris, T. R. Rhoads, S. E. Walden, T. J. Murphy, R. Meissler, y A. Reynolds, «Gender Equity in Industrial Engineering: A Pilot Study», 2023.
[18] J. Mills, M. E. Ayre, y J. Gill, Gender inclusive engineering education. Routledge, 2011.
[19] A. Powell, B. Bagilhole, y A. Dainty, «How Women Engineers Do and Undo Gender: Consequences for Gender Equality», Gend. Work Organ., vol. 16, n.o 4, pp. 411-428, jul. 2009, doi: 10.1111/j.1468-0432.2008.00406.x.
[20] Suzanne Franzway, Rhonda Sharp, Julie E. Mills, y Judith Gill, «Engineering Ignorance: The Problem of Gender Equity in Engineering», Front. J. Women Stud., vol. 30, n.o 1, pp. 89-106, 2009, doi: 10.1353/fro.0.0039.
[21] N. L. Wilson, T. Dance, W. Pei, R. S. Sanders, y A. C. Ulrich, «Learning, experiences, and actions towards advancing gender equity in engineering as aspiring men's allyship group», Can. J. Chem. Eng., vol. 99, n.o 10, pp. 2124-2137, oct. 2021, doi: 10.1002/cjce.24212.
[22] D. Sambunjak, S. E. Straus, y A. Marušić, «Mentoring in academic medicine: a systematic review», Jama, vol. 296, n.o 9, pp. 1103-1115, 2006.