Nourishing girls' passion for Computing Sciences: let's eliminate barriers and build bridges

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Abstract

Female under-representation in Computing Sciences is a structural problem and hence, solving it requires a profound social change. Indeed, our millenary cultures' collective unconscious contains ingrained positions and stereotypes which force us to assign greater family obligations and lesser resources to girls than to boys. This in turn leaves girls ill-equipped to envisage Computing Sciences careers in their future, or even STEM (Science, Technology, Engineering and Mathematics) careers in general.

In this article we analyse the social context of this predicament, identifying some conflicts that lead to gender gaps, such as inequitable conditions, lack of role models and misogynous violence manifestations in contemporary society. We also explore and propose ideas to alleviate these situations, as well as to resolve them in the longer term. Crucially, we highlight the importance of teaching girls, as from the first stages of their education, to reason correctly and to detect vicious lines of reasoning and be able to prove the false. Such tools permit girls to address situations of degradation and aggressions with integrity and determination. Logic Programming has an essential role to play in this respect.

Keywords

Gender gap, Girls, Compulsory education, Logic Programming, Logical Thinking

1. Introduction

Our society's collective unconscious inherited positions and stereotypes from millenary cultures causing us to adjudicate to girls and women greater family obligations and lesser resources. Therefore, they end up with fewer possibilities than their male counterparts, to choose Computer Science as a career, or in general, any STEM career (Science, Technology, Engineering and Mathematics).

Female sub-representation in Computing Science(CS) is a direct consequence of male over-representation in every sphere of power and decision-making. To solve a problem we need to eliminate its causes. It follows that given that male over-representation in power and decision-making realms is a universal and persistent consequence, the task of attracting girls into CS is not an easy one. Centuries of conditioning either through violence or through indoctrination either direct or subliminal (codified even in our languages) have normalised the acceptance of arbitrary hierarchies in our collective unconscious. This makes not only sexism but also endosexism (a phenomenon parallel to endoracism [1]) prevalent.

Advances in STEM disciplines have brought progress in many aspects such as health, agriculture, infrastructure and renewable energy. It is therefore fundamental to prepare students, in particular female ones, to enter these careers [2], as indicated in the 2030 Agenda for Sustainable Development adopted by United Nation's General Assembly. Of its 17 objectives, those especially relevant to our work are the Sustainable Development Goals (SDG) 4, on quality education that is inclusive, equitable and promotes continuous learning for all, and SDG 5, on gender equity and empowerment of women and girls. Clearly, these SDGs highlight the importance of tackling the subject of female under-representation in CS and in all STEM careers.

Habitual narratives on this theme tend to under-estimate the weight of context, for instance limiting themselves to measures to "motivate" girls (as though the cause of their under-representation resided in them). Such measures are necessary, but very insufficient. In this article, in contrast, we shall highlight the weight of context, at the same time as we propose concrete and useful ways to de-programme ourselves as a society, from those arbitrary hierarchies that are the true cause of female attrition in our discipline. We also propose strategies to detect and resist every effort to reinforce an unjust status quo which ultimately, damages all persons –since, to paraphrase Simone de Beauvoir [3], where one sex suffers, everyone does. All persons are interconnected. Let's all, therefore, join our efforts towards solidarity.

2. The seriousness of the problem- and some palliative measures

According to UNESCO [2], women in the world represent only, 35% of post-secondary in STEM careers. Gender gaps reduce possibilities of innovation and new perspectives to tackle present and future challenges. We next discuss the causes of this pitiful situation.

2.1. Unequal conditions

In an ideal world, human rights would naturally extend to all people, e.g. women would not be collectively poor in time or money or patrimonially, because their essential work that generates and maintains the most important capital, which is humanity would be recognized and remunerated justly.

The most important human right that women lack is the one insufficiently described in Article 23.3 of United Nation's Universal Declaration of Human Rights [4]: *"Everyone who works has the right to just and favourable remuneration ensuring for himself and his family an existence worthy of human dignity, and supplemented, if necessary, by other means of social protection."*.

Such a formulation remits us subliminally to the traditional interpretation of "person that works", since it does not explicitly count as work the socially essential work of creating the next generation of citizens and/or taking care of up to three generations at a time. Neither does it make it explicit how, concretely, those opportunities could materialize equitably towards a person whose non-remunerated social loads impede her from accessing studies or paid work in equality of conditions, and who in addition must compete in that market with those who do not have those obligations.

2.2. Scarcity of role models

One of the key factors identified in research on female under-representation in CS [5, 6, 7], is the paucity of female role models -which turns our problem into a vicious circle. This paucity has in turn very deep causes, many of which will be analysed in this article. In consequence, we cannot expect role models to multiply until after having healed the *causes* of that absence. Such causes, nevertheless, are often ignored in efforts that try to suppress the symptom instead of trying to heal its cause, and end up introducing more inequity: trying to provide more female role models in order to attract more girls into computing results for instance in regulations that require each committee to exhibit a minimum of representatives of each sex (say, 20% in a department where only 7 percent are women). The result is not access of women to power and decision-making positions (a move that WOULD indeed inspire girls), but their overloading in order to achieve that ratio. A solution that instead, would tend to heal the cause would start by admitting that women are already overloaded with the every onerous, ad-honorem work of taking responsibility for the next generation with little help and often in double duty from the need to also add an under-paid job. In addition, be it through inertia or to favour their own network, their bosses tend to delegate service jobs to them, reserving jobs of more recognition and prestige to the men, as has been done for centuries.

This continues to happen despite the existence of public policies such as parity laws [8, 9] that collaborate trying to include women in jobs traditionally reserved for men and in positions of leadership, among other measures. It is a step forward, but because it leaves the causes of the problem intact, it can

turn against women themselves. For instance, it is obvious that most of the women who get access to positions of leadership or prestige despite a double workload, cannot but be extremely capable and meritorious, else they could not take care of so much, so successfully.

Nevertheless, numerous studies in the most diverse disciplines demonstrate that the irrelevant factor which is the gender of contestants affects the results of "merit-based" contests. This happens for instance in academic articles' revisions, where double-blind refereeing is advised as a way of mitigating the bias [10, 11]; and also in the evaluation of musicians applying for an orchestra, where the number of women who win these contests goes dramatically up if no indication is given as to their gender [12]; and also in the evaluation of magicians, since the same magic trick shown without showing the artist, receives stellar evaluations if it is announced that the magician is a man, and far less positive evaluations if they are announced to be a woman [13].

This situation condemns us in all cases: if we do not win a contest we deserve to win and which is supposed to be won "by merit", it is reasonable to suspect –since that possibility is very concrete– that we lost it only because of our gender. If we are chosen without a contest only to complete quotas exclusively based on gender, we fall under the suspicion that we probably do not deserve it, which deletes authority from us at the time of exercising that post.

In fact, we women do not want to occupy positions to which we are elected only to complete quotas based exclusively on gender. We believe, on the contrary, that the election must be firmly justified by the candidate's academic and professional merit. But, how do access, in a world in which evaluations depend more on the postulant's gender than on their capacity, to the positions for which we are really well capacitated? This question merits a much deeper study than what we can offer here, but there are two sketches of a reply which have proved conducive to our personal experience: (a) actively soliciting female postulants[1]; (b) taking into account, at evaluation time, under which handicaps the candidate has been able to achieve superlatively good results[2].

We must also make sure that as much as possible, evaluators do not have access to information on the gender of the person who postulates, in order to eliminate the unconscious application of biases, obviously present in all of us.

2.3. Stereotypes and gender-based microaggressions

Society at large suffers from gender biases which, in STEM careers in particular, appear either explicitly or implicitly, at around 6 years of age, when girls start to doubt their own intelligence, whereas boys continue believing that their gender is intellectually privileged [14]. Such stereotypes, reinforced societally throughout life, make it difficult for women to access careers typically reserved for men. One of the factors that reinforces such biases is gender-based microaggressions, studied as from 1966 by Luis Bonino [15].

In [16] Benalcázar y Venegas define micro-Machisms as "the daily toxic-male aggressions of low intensity, with no evident physical consequences, committed by both men and women, and which are not questioned due to the naturalization of inequitable gender schemas". Bonino distinguishes three categories of micro-Machism: coercive or direct, indirect and hidden controlling hidden controlling manoeuvres, and those of crisis. Benalcázar-Luna y Venegas add a fourth category from the indirect one, which they call utilitarian: it is not so much what is actively done, but what is not done and delegated to a woman.

Sometimes aggressions are disguised as "jokes", a deliberate ambiguity that debilitates our ability to react. It is worth it, therefore, to especially examine the sub-texts, not only of insults posing as jokes,

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[1]Anecdotally: as a committee member to fill an important academic position where no women had responded to the call, Dahl and the only other woman in that committee insisted on personally soliciting candidacies of perfectly capable women who probably had not been informed of the vacancy, or have not had the courage to apply. Among others, a woman candidate then showed up who was superior to all others, and who largely won the contest with no need of quota.

[2]It is obvious that successes achieved under, and in spite of, enormous social loads, such as military service where it exists, or gestation and life maintenance of a human being, must be evaluated as much more meritorious than the same achievement done by someone who is not overcharged. At the very least, one must bear in mind the evidence of exceptional capability shown by the ability to successfully attend to a multiplicity of important functions.

but of similar other aggressions. In society as a whole, women are insulted either with reference to their sexual morals or comparing them with sub-human entities; whereas men are typically insulted through associating them with women, weakness or femininity. The subtext of these insults is cultural adhesion to the myth that feminine traits are inferior to masculine ones, and that women must adhere to a sexual morality that is not expected from men, historic appropriators of female bodies. The possible reaches of such symbolic violence are clearly seen when one considers their re-traumatising effect upon the enormous percentage of women who have been sexually aggressed, even in childhood (30 percent of girls between 9 and 10, counting only incest, according to [17]). Sub-texts of "jokes" or insults to women in the workplace contain in addition, in our experience, a degrading intention. It is therefore fundamental to develop from childhood the capacity to decodify, in daily language, the subtleties of usages and expressions that dissimulate a misogynous or discriminatory character.

2.4. Language, generator and maintainer of dominations- and its potential to help restitute rights

On average and globally, laws only recognize for women three quarters of the human rights that are given to men [18]. Crucially, and in addition to the already mentioned lack of the right to equitative remuneration, women see their right to personal security enormously diminished, due to the sexual violence of some men. Laws that are deemed imposed in order to eradicate such violence, as well as judges in charge of applying them, sometimes exhibit incredible indulgence towards the perpetrators. Moreover, in those rare cases in which victims dare denounce their aggressors formally, they tend to re-victimize the victims, questioning for instance how they dressed, or judging the "morality" of the victim instead of the criminal fact [19, 20].

Although the problem's solution is not within our immediate reach, it is important to keep all this context in mind when we analyse the problem of female sub-representation in Computing Science. The measures that are within our reach, and which we will next discuss, are only palliative, if they do not tend as well to bring to consciousness the need to evolve towards laws and their application that empower us and protect us all equally.

The first palliative measure we propose is to develop in girls and boys the capability to detect and analyse in which ways language itself promotes and perpetuates gender-unequal human rights. A preliminary observation is that it is necessary to dehumanise any group one wants to dominate, so as to be able to establish an arbitrary hierarchy that helps "justify" exploiting or unjust uses one wants to make of that group. Thus, for instance, the habit of using "man" as synonymous of "human being" subliminally excludes women. In this sense, some initiatives are proving helpful, such as talking of "Human-Machine interface" or "Person-Machine" interface, rather than "Man-Machine interface".

From linguistic exclusion to simple expulsion of the human race, there is only one step, as attested by insults that not only denigrate women in general, but also derive the insult towards some woman normally not responsible: the mother of whom provoked the insult. Instead, "muy padre" (literally, very father), denotes in many Spanish speaking countries something superlatively good. Examples abound and are quite studied by linguists, e.g. words that are in principle gender-neutral end up being used derogatorily in the feminine form while praisingly in masculine, e.g. "public man" vs. "public woman" [21].

Becoming conscious of these uses and their subliminal message would allow us to dismount linguistic mechanisms of female denigration or exclusion [22], leading to their eventual eradication from all languages. It would also help to inform children that many of those mechanisms did not evolve spontaneously, but were instead created and imposed on purpose by those who had the power of doing so: the overwhelmingly male academics of language[3] [24, 25].

Such consciousness evolution, if reaching not only the girls but all members of an entire generation, would allow us to start a conscious and habitual disruption of the toxic subliminal message underlying

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[3]For instance the grammatical rule in French that suggestively reads: "masculine takes precedence over feminine" distorted the French language, which until then required a compound subject to agree in gender with its last element, e.g. "Anne, Pierre, Jean et Marie sont be**lles**", but "Anne, Pierre, Marie et Jean sont be**aux**" [23].

all these cultural manifestations (concretely, female "inferiority"), training the new generation in the detection and therefore de-activation of pernicious sub-texts and of all the female-degrading implications that language contains. Such a de-activation involves, in our opinion, two basic axes: teaching to detect and question the toxic codes included in language and other cultural manifestations, and teaching to reason correctly, as we discuss in the next section. There are compilations of sexist terms which can aid teachers in the first of these tasks [22]. It is interesting that, at the same time as language crystallizes and perpetuates unjust archaic habits and thoughts, it also contains renewing possibilities: the surprise that causes, for instance, a literal paraphrase of some misogynous saying, for instance, immediately prompts us to reflect. New, equitable terminologies that spread spontaneously tend to effect a change in society, just as much as those that oppress tend to replicate oppression.

2.5. Logic to the rescue

In tandem with the re-signification and reformulation of terms that perpetuate inequity, it is useful to teach how to recognize and deactivate those fallacies on which inequity is based. For instance, a fallacy commonly used by judges, legislators, lawyers and the law in general, which allows them to blame and re-victimize victims of rape is the "reasoning" that if the victim was dressed or acted "provocatively" (in whose opinion?), or was for instance in a dangerous neighbourhood, she is the one to blame for the rape having "happened" [19, 26].

To clearly expose such a fallacy, it is useful to use analogies in a different context where gender does not intervene (and therefore, misogynous prejudices cannot play out) to clearly de-construct that fallacy: it is just as absurd as saying that the blame of a bank robbery lies not in the thief but in the bank itself, for its ostentatiousness of its expensive buildings or simple assets report.

It is also useful to have enough knowledge of logic to detect and make evident which type of fallacy is involved: that of non-sequitur, whose conclusion is "obtained" from premises that are not logically connected to it (from the premises: "the victim was acting provocatively, dressed provocatively and/or was in the wrong place at the wrong time", the supposed conclusion "the rapist merits a reduced sentence" DOES NOT follow [20, 27]). It's also useful to analyse what cultural conditioning can hide behind the sadly easy acceptance of such "reasoning" on the part of even judges and educated people. Also, what cultural conditionings in our collective unconscious predispose it to set aside the responsibility of a rapist, even regarding a crime for which he is solely responsible? Such predisposition is clearly seen, for instance, in the euphemism "domestic violence" or "violence against women", which hides the overwhelmingly majoritarian gender of the perpetrator, discharging the problem on their victims through omitting even mention of the perpetrator, as though it was a problem pertaining to the victims only, that only they should resolve. Collective acceptance of such euphemisms contributes subliminally to the problem's non-resolution. New generations alert to correcting toxically indoctrinating euphemisms and alert to question illogical reasonings, could replace them, respectively, by terms more realistically descriptive, and by correct and demonstrable reasonings, thus contributing to making solutions possible. In Section 3 we give technical details on the possible uses of logic in the context that occupies us. We must stress, however, that true solutions to the problem need a previous, necessary and also monumental work, namely the transition from our societies of male hegemony towards solidarity and equitatively cooperative societies.

3. Supplemental Ideas for Forging Girls' Path to Computer Science

In the context described in Section 2, it it is crucial to foster a passion for science and technology in girls, showing that, despite societal prejudice, it is both possible and beneficial for them to pursue these fields before society indoctrinates them against themselves. Consequently, we are convinced that initiatives to promote Computer Science need to start at a young age and be maintained over time with definitive actions aimed at preventing women from having to choose between a career and motherhood, while ensuring equal conditions and opportunities. While the required change is both structural and significant, numerous immediate actions can and should be taken to advance as much as

possible in this direction. Some of these measures are outlined below.

Enhance the visibility of women's roles in Computer Science: In response to the scarcity of female gender STEM professionals, it is crucial to highlight women in CS to inspire girls and young women. Potential strategies include:

- Efforts should be made to include a significant number of women among the *teaching assistant* or *teachers* in initiatives aimed at guiding girls, to counteract the perceived scarcity of female role models in this discipline. However, this should not result in additional burdens for women. Appropriate compensation, mandated by law, should be provided to allow participants to allocate their time to these initiatives—for instance, by reducing their teaching, administrative, or research workload. Such social service should also be formally acknowledged in professional evaluations, promotions, and similar contexts.
- Support initiatives with brief research tasks that highlight not only men but also women who have contributed to the discipline. In this sense, it is recommended to focus on contemporary scientists who have been pioneers in different areas of development[4].
- Consider organizing talks featuring successful women from academia, foundations, and industry to offer valuable insights and inspire future generations.

Equal Opportunities in Educational Institutions: In Argentina, as well as worldwide, CS has its own space in the curricula of the secondary level. This contributes to narrowing the training gap between men and women. However, in some countries, including those that are highly developed, false choices are created between courses that should be compulsory, such as mathematics, French or home economics, which are absolutely not equivalent in terms of how many doors they open or close with respect to possible jobs and professions. Girls are frequently the most affected, as they may be discouraged by parents, boyfriends, or even student counsellors from selecting maths courses [28] necessary to, among many other jobs and activities, be able to enter a career in CS[5].

In addition to these pressures, the representation and visibility of women in STEM fields are low. It is essential to begin addressing this issue from the early stages of education and to sustain efforts at every level.

In general, there is a discourse in educational institutions that focuses on promoting gender equality. However, female students often experience difficulties due to their status as women. In some cases, they are denied the opportunity to manipulate computers or are relegated to different tasks, such as artistic or crafts, solely based on their gender [29].

In other situations, classmates monopolize equipment and resources, because of their desire to stand out, or simply because they already know how to operate them. This dynamic merits deeper attention in educational contexts, as it could have significant implications in opportunity equity inside the classroom, as well as in future work environments. In these cases, it is the teacher's responsibility to guarantee a fair and equitable environment inside the classroom. They must be attentive to any manifestation of inequity or injustice, be it gender-based or of any other kind. In promoting the active participation of all students, and intervening in discriminatory situations, teachers significantly contribute to creating a space of learning which is inclusive and respectful.

It is then crucial to educate teachers, parents, school companions and school advisors, so that they apply to girls the same criteria (e.g. demonstrated capacity) that they apply to boys, when it is time to advise them on subjects to choose or careers to consider, and so that they are treated justly when opportunities, equipment, teacher's time, etc, need to be shared.

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[4]https://medium.com/a-computer-of-ones-own
[5]Anecdotally, in a graduate course taught by Dahl, three women graduate students shared a similar experience: their student counsellor discouraged them from choosing mathematics, arguing that it was too "difficult" for them, despite their sufficient grades in the required previous course. Conversely, the boyfriend of one of these students, who had a lower grade in the same prerequisite, received encouragement to proceed with the subject.

Some companies, like L'Oreal, are leading the necessary change, It's a good strategy for any company, since the benefit is not only for girls and science, but also for the company, which acquires notoriety as a leader.

We next briefly describe some existing examples.

1. *For Women in Science*[6] is a joint initiative by The L'Oréal Fund for Women and UNESCO, which up to date has given prizes to more than 100 winners, five of which have subsequently earned a Nobel Prize. Within this initiative, there is a new version *Pour les filles et la science*[7] destined to promote women in scientific fields and careers from the second year of high school.

2. The *ADA Program* [8] organizes workshops designed for primary school children, aiming to promote interest among girls and young women in technology-related fields of study.

3. Along these lines, the Ada Lovelace Day has happened every year uninterruptedly in different locations of Latin America, featuring talks and ludic workshops for girls 10 to 12, aiming to promote STEM careers and encourage them to continue their studies and understand the importance of woman's role in Sciences. This is an outgrowth from the First Day of STEM Wokshops for girls and for teenage women which was organized in 2022 by Facultad de Ciencias Exactas y Naturales of the Universidad de Buenos Aires (FCEyN-UBA), the Facultad de Ingeniería Química and the Facultad de Ingeniería y Ciencias Hídricas (FICH-UNL) of the Universidad Nacional del Litoral (FIQ-UNL), and the Universidad Nacional de Rosario (FCEIA).

4. *Girls who code*[9] is a global initiative that introduces coding to primary school girls in an engaging and fun way. It offers summer courses for young women at the secondary level to develop essential skills for STEM careers. At the university level, it provides targeted programs. This initiative is now active in the USA, Canada, Great Britain, and India.

5. Since 2016, the Niñas Pro [30] initiative in Chile has been developing activities to empower girls and adolescents by teaching them to program and inspiring them to consider scientific and technological careers in their future. The educational model is based on four projects: Empower, Inspire, Encourage and Promote. By 2021, the initiative expanded to other Latin American countries such as Panama, Mexico, Venezuela and Brazil.

These initiatives, among others that different organizations, institutions and companies have developed, aim to reduce the gender gap in the selection of STEM careers.

The university, a viable option: For many children and young people, but particularly girls and young women, the university represents an unattainable instance in their lives for different reasons: financial constraints, lack of family motivation, and pregnancies that disproportionately affect student mothers rather than fathers, who ideally should equally share responsibility for the new life, and so on [31, 29]. According to our experience [32], initiatives involving Computer Science educators and students can help bridge the gap to higher education. When such programs are introduced at the secondary level, they allow students to engage with university life and mentors early on. Moreover, when meetings are held on the university campus, students become familiar with the various parts of the buildings and their services, such as the library and dining hall.

Familiarity with the university environment helps students integrate more effectively, which enhances their readiness for academic life and long-term retention. Such initiatives have a positive impact on students' decisions to continue their studies and on their selection of the university hosting these activities as their educational institution.

The university's initiatives for primary-level students empower children, particularly those previously unexposed to CS. Such efforts encourage a passion for learning and offer a vision of the future that includes the prospect of pursuing higher education.

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[6]https://www.forwomeninscience.com/
[7]https://www.forwomeninscience.com/authority/for-girls-in-science
[8]https://www.inmujeres.gob.es/areasTematicas/SocInfo/Programas/Ada.htm
[9]https://girlswhocode.com/about-us

Educational material without stereotypes: The UNESCO report [2] highlights that the portrayal of male and female characters in school textbooks conveys explicit and implicit messages to children about their roles and abilities in STEM. It also points out that educational materials often fail to depict professional women in STEM careers, or when they do, they tend to use language and imagery that places women in subordinate roles. These messages can reinforce gender stereotypes and discourage girls from pursuing careers in these areas.

Similarly, the activities depicted in fictional worlds should portray both women and men in non-stereotypical roles. For instance, in a science fiction setting, women should not be shown merely serving coffee to distinguished male astronauts. Moreover, narratives should also include women as integral members of a team and in leadership roles. As an example, the gamified activity for teaching Logic Programming [33], which is designed for primary school students, features an equal representation of male and female characters. In addition, it showcases women in roles traditionally associated with men.

Integrate Computer Science in Primary Education: The lack of access and exposure of girls from an early age to technological tools and knowledge contributes to widening the gender gap. This disparity separates them from STEM disciplines, distancing them from vocations and professions in these fields and reducing their future job prospects, economic opportunities and their ability to influence an increasingly digitized world. Thus, many of the initiatives targeting girls that are carried out are extracurricular activities, such as, *Niñas Pro* [30] and *Ada Lovelace Day*[10].

There is a vacancy in relation to the approach to Computer Science in compulsory education, especially regarding the specific knowledge areas of the discipline that should be taught at each educational stage and level. In this sense, in Argentina, there are some proposals on the inclusion of CS in Argentine primary education [34], supported by the Fundación Sadosky. Similarly, Labhart [35] proposes to address this inclusion from a gender perspective.

From our standpoint, we hold that addressing the teaching of programming through *Logic Programming* at the primary educational level is not only feasible, but also, is crucial for the development of Computational Thinking and Logical Thinking [33, 36].

Furthermore, we recommend working in interdisciplinary projects related to the subjects taught in primary school curricula. For instance, exploring a theme from Literature, such as detective stories linked to investigative activities, or a topic from Natural Sciences associated with ecology or social good activities [33, 36].

Public policies to narrow the gender gap: In this sense, concrete and systematic measures are required that not only ensure the inclusion of women in STEM fields, but also actively address gender barriers and stereotypes that may deter girls and adolescents from considering these careers as viable options. This involves implementing educational programs, awareness campaigns, and equal opportunity policies that actively promote the equal participation of women and men at all levels of education and the STEM industry.

Breaking the myth that women are not good for science: Dispel the misconception that women are deficient in mathematics and logic [37, 28], and science in general, and highlight their relevance in the STEM field.

In this context, regarding the recognition of female contributions, we believe that we must raise awareness with historical data, about the fact that women were pioneers in the field of computing: Ada Lovelace and Grace Hopper, among many others whose histories are not always known and are not widely recognised.

Conversely, we are convinced that we must show that mathematics can be fun and attractive through the use of games and puzzles, encouraging and inspiring girls to explore these disciplines.

We also believe that we should inspire girls to enjoy mathematics and logic, through participation

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[10]https://www.fiq.unl.edu.ar/culturacientifica/ada-lovelace/el-evento/

in competitions, such as Olympiads. This is because a significant number of girls have a negative perception of their mathematical skills compared to boys, leading to increased anxiety during examinations in these disciplines [38]. In this regard, in our primary school classroom intervention, we introduce students to Logic Programming through a fun gamified activity, in which all participants, including teachers, assume the role of detectives whose objective is to find the suitcase thief [33].

Bringing Logical Reasoning Closer: Building on the previous point, where we consider it relevant to highlight logic, it is our interest that concepts related to this area of knowledge are introduced in the early stages of education. A simple way to achieve this for a population of this age range is through the teaching of Logic Programming. This paradigm allows students to be introduced to programming and develop not only Computational Thinking skills, but also Logical Thinking ones. In this work, we consider that *Logical Thinking mainly focuses on the abilities needed to identify entities (e.g. objects, concepts) and relationships between them, and to understand, incorporate and soundly use the rules of logical inference relevant to deriving new, implicit ideas in everyday activities, and to reason about and judiciously choose among different logical formulations of the same problem* [33].

In this way, we empower girls with the ability to reason analytically and critically, constructing their own arguments and deriving new conclusions based on evidence. They are also provided with the necessary tools to be able to discern between valid and fallacious arguments, as well as to identify contradictions and to be able to defend their own arguments effectively. These tools enable them to deal with hostile situations of degradation and aggression with integrity and determination, while confidently and appropriately defending their reasoning.

Training new women leaders: Leadership training involves working in groups, where members take roles to solve a problem. However, on some occasions, this methodology can be a disadvantage for girls and an advantage for boys [2]. For instance, some studies have shown that children are capable of assuming leadership roles and articulating and advocating their perspectives, whereas girls often adopt stereotypical, subordinate, and more passive roles [39].

In this sense, we believe that the abilities of Logical Thinking may be useful tools for supporting their arguments with confidence. Regarding passive attitudes that girls might take, in our classroom experience [33], which takes place within school hours even though it is considered extracurricular, groups of teachers give equal opportunity for leadership roles to all students, in particular girls. The educators possess an in-depth understanding of the individual traits of both female and male students, which enables them to anticipate behaviours based on the observed patterns. Likewise, we count on the tutors who supervise the experience to adequately manage the gender dynamics present in interactions between students.

4. Conclusions

Society must fundamentally modify its set cultural positions and damaging stereotypes to be able to integrally address gender (and other) gaps. As explained in [40, pp. 31-33], modern epigenetics studies demonstrate that, over millions of years of evolution, our brain has developed a natural tendency towards solidarity and mutual cooperation. Still, within domination systems these capabilities are inhibited through socialization, values and institutions. Stress, which is endemic in societies of domination, can inhibit our capacity for empathy and our tendency to care, work together, help and share. Added to this stress is the fusion between care work and coercion that domination has constructed, which leads to negating (endo-discrimination) and deflating fear and anger towards the marginalised groups. Added stress factors are: the socialization of boys into confusing masculinity with domination and violence, and the consequent devaluation of everything stereotypically associated with "inferior" women, such as caring for others and non-violence. The subordination and devaluation of women and of everything "feminine" have truly caused a lot of harm not only to women, but to humanity as a whole [40, p. 287]. We urgently need to reinforce global campaigns towards gender relationships that are equitative and

non-violent, supported by progressive world leaders.

Thus, we must question and redefine tacit traditional gender norms that perpetuate inequity and limit opportunities for girls and women, simultaneously depriving men of their very humanity. Such changes must occur in all environments: at school, at home, in the workplace and in public spheres. In this sense, we believe it crucial that girls connect with CS early in life, preferably through activities led and built by women. Logic Programming offers an opportunity to bring girls and boys near to fundamental concepts of programming and logic, such as knowledge representation and valid reasoning. Knowing how to reason soundly allows us not only to examine our own mental processes in order to verify if they are correct and consistent, but also to detect vicious lines of reasoning to which we are constantly exposed; for instance, through propaganda, social networks, or AI systems that have "learnt" different biases and impose them on us without prior warning. This capacity to think logically allows us to defend ourselves, through preparing us to clearly explain (not only to ourselves but to others) why those reasonings are false.

This disciplinary approach should be maintained throughout compulsory education and be reinforced by public and private policies. These policies must guarantee that girls, who become professional women, are able to perform to their fullest potential in diverse work environments.

Acknowledgments

References

[1] E. Pineda, Racismo, endorracismo y resistencia, Editorial el Perro y la Rana, 2017.

[2] UNESCO, Cracking the Code: Girls' and Women's Education in Science, Technology, Engineering and Mathematics (STEM), UNESCO, Paris, 2017. doi:`10.54675/QYHK2407`.

[3] S. De Beauvoir, Le deuxième sexe, Éditions Gallimard, Paris, 1949.

[4] ONU, Universal Declaration of Human Rights, Res.217 A (III) (1948).

[5] V. Dahl, Analysis of female underrepresentation in computing sciences departments—what can be done?. , Technical Report 91-11, School of Computing Science, Simon Fraser University, 1991.

[6] V. Dahl, Yes, You Can - Letter to Young Women Scientists Blossoming in Men's Fields, Logic Programming Newsletter. Reprinted from: SCWIST Newsletter, 14(1):4, Jan. 1997. 11 (1998) 6.

[7] V. Dahl, On False Choices Affecting Female Representation in Science and Technology. Invited talk, in: CASCON'96 Workshop, Toronto, Canadá, 1996.

[8] Ley 27.412, Ley de Paridad de Género en Ámbitos de Representación Política, 2017.

[9] Ministerio de Ciencia, Tecnología e Innovación - República Argentina, Proyectos de Redes Federales de Alto Impacto: Convocatoria https://www.argentina.gob.ar/ciencia/financiamiento/redes-alto-impacto-2023, 2023.

[10] M. Krawczyk, M. Smyk, Author's gender affects rating of academic articles: Evidence from an incentivized, deception-free laboratory experiment, European Economic Review 90 (2016) 326–335.

[11] A. R. Kern-Goldberger, R. James, V. Berghella, E. S. Miller, The impact of double-blind peer review on gender bias in scientific publishing: a systematic review, American journal of obstetrics and gynecology 227 (2022) 43–50.

[12] C. Goldin, C. Rouse, Orchestrating Impartiality: The Impact of "Blind" Auditions on Female Musicians, The American Economic Review 90 (2000) 715–741.

[13] P. Gygax, C. Thomas, A. Didierjean, G. Kuhn, Are women perceived as worse magicians than men?, Social Psychological Bulletin 14 (2019) 1–19.

[14] L. Bian, S.-J. Leslie, A. Cimpian, Gender stereotypes about intellectual ability emerge early and influence children's interests, Science 355 (2017) 389–391.

[15] L. Bonino Méndez, Los micromachismos y sus efectos: claves para su detección, La violencia contra las mujeres. Prevención y detección. (2004).

[16] M. Benalcázar-Luna, G. Venegas, Micromachismo: manifestación de violencia simbólica, UTCiencia 2 (2017) 140–149.

[17] Dussy, Dorothée, Le berceau des dominations:Anthropologie de l'inceste, livre 1, Editions la Discussion, 2013.

[18] The World Bank , Gender Data Portal https://genderdata.worldbank.org/, 2024.

[19] P. R. Ríos, De la "sentencia de la minifalda" a La Manada: juicios sobre agresiones sexuales y estereotipos sexistas, Diario El Salto (2018).

[20] S. McKay, Out for a good time? Yes. Dressed to be raped? No. How women choose to dress can never be taken as an invitation for assault, The Irish Times (2018).

[21] R. Lakoff, The Language War, University of California Press, California, 2020.

[22] E. Saner, Sexism in dictionaries: why are 'hussy, baggage and filly' still used to describe a woman?, 2019. URL: https://www.theguardian.com/lifeandstyle/2019/jul/03/hussy-baggage-bit-filly-dictionary-definitions-woman, accedido Abril 2024.

[23] M. Schoenborn, Quand le masculin l'emporte sur le féminin (2017). URL: https://gazettedesfemmes.ca/13898/quand-le-masculin-lemporte-sur-le-feminin/.

[24] E. Viennot, Non le masculin ne l'emporte pas sur le féminin ! Petite histoire des résistances de la langue française, Editions IXE, 2014.

[25] J. Sorin, Comment s'est imposée la règle du "masculin l'emporte sur le féminin"?, 2024.

[26] A. Learmonth, Anger as man who raped teen avoids prison, The Herald (2023).

[27] A. Fantz, Outrage over 6-month sentence for Brock Turner in Stanford rape case, CNN - Cable News Network. A Warner Bros. Discovery Company (2016).

[28] J. S. Hyde, J. E. Mertz, Gender, culture, and mathematics performance, Proceedings of the National Academy of Sciences 106 (2009) 8801–8807. doi:10.1073/pnas.0901265106.

[29] V. I. Seoane, Géneros, cuerpos y sexualidades: experiencias de mujeres en escuelas técnicas de la ciudad de La Plata, Ph.D. thesis, Buenos Aires: FLACSO. Sede Académica Argentina, 2013.

[30] M. Vidal, J. Maldonado, T. Bracamonte, F. Miranda, A. Labarca, J. Simmonds, Niñas Pro: An initiative to educate, inspire and empower women, in: Proceedings of the XIII Congress of Latin American Women in Computing, 2021, pp. 35–46.

[31] A. R. Quisumbing, L. Haddad, C. Peña, Are women overrepresented among the poor? an analysis of poverty in 10 developing countries, Journal of Development Economics 66 (2001) 225–269.

[32] J. Rodríguez, G. Grosso, R. Zurita, L. A. Cecchi, Intervención de la Facultad de Informática en la enseñanza de Ciencias de la Computación en la escuela media basada en robótica educativa, in: XI Congreso de Tecnología en Educación y Educación en Tecnología (TE&ET), 2016.

[33] L. A. Cecchi, J. P. Rodríguez, V. Dahl, Logic programming at elementary school: Why, what and how should we teach logic programming to children?, in: D. S. Warren, V. Dahl, T. Eiter, M. Hermenegildo, R. Kowalski, F. Rossi (Eds.), Prolog - The Next 50 Years, number 13900 in LNCS, Springer, 2023.

[34] Fundación Sadosky, Una propuesta curricular para la inclusión de las ciencias de la computación en la educación primaria y secundaria de las escuelas argentinas, 2023. https://fundacionsadosky.org.ar/propuesta-curricular-cc-vocaciones-educacion/ Accedido Abril 2024.

[35] M. Labhart, How and why teach computer science from a gender perspective in schools?, in:

Proceedings of the XV Congress of Latin American Women in Computing, 2023, pp. 79–90.

[36] V. Dahl, L. A. Cecchi, Introducing Prolog in Language-Informed Ways, in: D. Warren, V. Dahl, et al. (Eds.), Prolog - The Next 50 Years, number 13900 in LNCS, Springer, 2023.

[37] I. F. Lantigua, El cerebro femenino, ¿no apto para las matemáticas?, British Broadcasting Corporation (2009). https://www.elmundo.es/elmundosalud/2009/06/01/neurociencia/1243882048.html Accedido Abril 2024.

[38] N. Ayuso, E. Fillola, B. Masiá, A. Murillo, R. Trillo-Lado, S. Baldassarri, E. Cerezo, L. Ruberte, M. Mariscal, M. Villarroya-Gaudó, Gender Gap in STEM: A Cross-Sectional Study of Primary School Students' Self-Perception and Test Anxiety in Mathematics, IEEE Transactions on Education 64 (2021).

[39] P. J. Leman, Y. Skipper, D. Watling, A. Rutland, Conceptual change in science is facilitated through peer collaboration for boys but not for girls, Child Development 87 (2016) 176–183.

[40] R. Eisler, D. P. Fry, Nurturing Our Humanity: How Domination and Partnership Shape Our Brains, Lives, and Future, Oxford University Press, Oxford, 2019.