Childhood, Science and Technology:
a gender analysis from the family, educational and cultural environment point of view

A research carried out by the UNESCO Regional Chair Women Science and Technology in Latin America - FLACSO Argentina with the Civil Association Chicos.net, and with the support of Disney Latin America

Coordinated by **Gloria Bonder**

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1 | Why this research?

There are still not enough studies to analyze gender differences and inequalities in Science and Technology in childhood, particularly in the first years of schooling. Hence, addressing how they are expressed at this stage rises interesting theoretical and methodological challenges, as well as challenges for the application of their results. Likewise, it opens up the possibility of influencing early on in the relationship of children with these fields of knowledge, which acquires special relevance within the framework of the Knowledge Society.

The research **"Childhood, Science and Technology: a gender analysis from the family, educational and cultural environment point of view"** intended to focus on this age group as a phase of life in which the first affinities, skills and values are developed, as well as self-evaluations related to these fields of knowledge in the family and school environment, and in a broader sense, through their cultural consumption.

In particular, how children in the first years of schooling are linked to the Science and Technology areas and activities, and detect whether stereotypes and gender biases are involved in this process.

As is evident, we do not assume that the way in which these links are made will continue throughout their lives, and even less that what happens in childhood can predict their adult choices. The main objective was to **generate knowledge about the conditions and factors that favor and/or limit in childhood the opportunities and possibilities of men and women to be interested, develop capacities and build a satisfactory relationship in the learning of science, technology, engineering and mathematics.** The selection of these disciplines was not random, but is related to a new field of learning, of global tendency, called STEM[1] which is based on the articulation of these subjects, to encourage the development of certain skills such as creativity, innovation and problem solving and whose objective is to improve the quality of education. To move in this direction, we looked for:

[1] STEM (Science, Technology, Engineering and Mathematics) is not a sum of disciplines, but a new field of learning based on the articulation of all of them. Therefore, its approach and practice is inter or trans disciplinary. Its fundamental purpose is to generate new skills and knowledge that provide innovative and effective solutions to solve the problems of the socio-economic and environmental context. It contributes to improving the quality of education and promoting job opportunities and high value-added ventures that positively affect the quality of life of our societies. (UNESCO, 2015)

- Identify and analyze gender biases in the development of interests, attitudes, valuations and representations of the STEM disciplines in children from 6 to 10 years of the three most populated cities in Latin America: Mexico City (Mexico), São Paulo (Brazil) and Buenos Aires (Argentina).

- Collect and analyze in parents, mothers and teachers, opinions, evaluations, expectations and representations about children in the STEM areas.

- Compare the representations on gender and in STEM in different geographical contexts and socioeconomic levels.

- Provide recommendations to promote the interest, motivation and participation of children in the STEM areas.

2 | Participants, time and place of this initiative

It was held between April and October 2017 by **Chicos.net** with the **UNESCO Regional Chair on Women in Science and Technology in Latin America - FLACSO Argentina**, sponsored by **Disney Latin America**. The research team was led by **Gloria Bonder** (director of the UNESCO Regional Chair on Women, Science and Technology in Latin America).

It was carried out in **Mexico City (Mexico), São Paulo (Brazil) and Buenos Aires (Argentina).**

In Mexico and Brazil, it was supported by local experts. In Mexico City, a team of researchers specialized in gender, education, science and technology from the National Autonomous University of Mexico, led by Judith Zubieta, collaborated. In São Paulo, local support came from the Regional Center of Studies for the Development of the Information Society (Cetic.br). The Regional Chair on Women, Science and Technology in Latin America was in charge of the general coordination of the project, the methodological design and the tools for field work.

3 | How was it carried out?

A methodological model was used that combined quantitative and qualitative techniques (focus groups and in-depth interviews).

Groups in study, techniques and sample:

- **Boys and girls between 6 and 10 years old,** residing in the City of Buenos Aires, Argentina (CABA as in the Spanish acronym for Autonomous City of Buenos Aires), Mexico City, Mexico (CDMX as in

the Spanish acronym for Mexico City), and São Paulo, Brazil (SP as in the Brazilian acronym for City of São Paulo), (CABA, CDMX and SP, hereinafter); of medium, medium low and low socioeconomic sectors (NSE1, NSE2 and NSE3, hereinafter).

An *online* questionnaire was designed and applied as a playful environment for children from public and private schools by city (total: 180). There were 6 focus groups of 10 participants each per city (60 children in each, total: 180).

- **Mothers and fathers** of boys and girls from 6 to 10 years old belonging to the aforementioned socioeconomic sectors, residents of the cities under study.

  300 mothers/fathers per city (total: 900) answered a structured quantitative questionnaire[2]. There were 6 focus groups of 10 participants per city (60 in each, total: 180), segmented by the same socioeconomic sectors.

- **Teachers: women and men of elementary level** in the cities under study, from different areas of education and public and private schools.

  Through a structured quantitative questionnaire[3] 200 teachers per city were consulted (total: 600). There were 6 focus groups of 10 participants in each one (60 in each, total: 180), segmented by the socioeconomic sector of the schools in which they work (NSE1, NSE2 and NSE3).

[2] Sampling design: non-probabilistic, incidental in points of high public concentration, control of quotas according to population strata of sex, socioeconomic sector, age of children and school management (public/private), with incidental selection of respondents.

[3] Same as above.

4 | What did we find?

4.1 How do boys and girls imagine, learn and practice STEM?

- **The favorite subjects of girls and boys are Physical Education and Mathematics**; however, there are variations between the three cities and by ages. The results clarify the belief, at a social level, that boys have more affinity for Mathematics and girls for Language.

In CABA, girls' interest in Mathematics decreases as they progress through the school, although the evaluations indicate that their performance in some contexts is greater than or equal to that of boys.

- However, in two of the three cities, **girls' interest in Mathematics decreases as they progress through the school.** This may be related to the fact that this subject tests the self-assessment of the capacities of women and men, unlike others where this factor may be more diffuse (for example, Language or Natural Sciences). In general, the way in which it is taught stimulates competition, both on the part of girls and boys and when its performance is evaluated, the speed at which the exercises are completed is considered, or it is considered as an indicator of greater ability. It is possible that men, for various reasons, conclude faster and generate a highly competitive environment while girls perform the tasks at another pace (which does not mean less understanding competence) and therefore do not receive the same evaluation by teachers and peers.

- **It is verified that when more hours are dedicated to this subject and the contents are worked in a playful way** (often, based on resources and specific experiences, such as the use of games and specific teaching materials), **the liking for this discipline is favored from the first years.**

- **Their motivation also increases when the pedagogical proposals allow them to assume an active role and the contents are related to subjects that attract them, and which they explore outside the school.** Practical activities related to this area (conducting experiments, getting to know nature, science museums and planetariums). Natural sciences attracts more girls, however, the activities are attractive to both boys and girls.

This preference is in tune with the *tinkering* movement, which is already being implemented in other regions, whose proposal is "play, manipulate, break apart, make a mess and try to fix" (Furman, 2016; Resnick and Rosenbaum 2013 [4]).

Although none of them chose Natural Sciences as their favorite subject, 80% of children between 6 and 8 years old really like to do experiments in their homes.

- **In their homes they perform different activities/games related to STEM,** mainly doing experiments and accessing audiovisual content (documentaries) related to the world of science. **In this space, without rules or established times, boys and girls show more interest in these activities than when they do them in school.**

- **Technological devices occupy a central place in their lives**, especially outside the school environment. Their use is not limited to a single and fixed place, they are ubiquitous: they move with them to different spaces and situations.

- **Boys and girls of all ages use them mainly to play, but girls also take advantage of the opportunities they provide for communication** with other people and to venture into artistic creation (making videos, for example).

- **Both inside and outside of the educational fields, there is no sharp division between "boys and girls games".** However, **girls depart, to a greater extent, from traditional gender stereotypes showing interest and participating in activities considered masculine**. Boys, on the other hand, have more restrictions to expand their options.

In CABA, 1 out of 2 parents believe that boys have more ability to use technology, although boys and girls are equally entertained by it.

[4] Furman, M. (2016). Educate curious minds: the formation of scientific and technological thinking in childhood. Buenos Aires: Santillana Foundation. Resnick, M., & Rosenbaum, E. (2013). Designing for Tinkerability. In Honey, M., & Kanter, D. (eds.), Design, Make, Play: Growing the Next Generation of STEM Innovators, pp. 163-181. Routledge.

Nine (9) out of 10 girls (between 6 and 8 years old) associate Engineering with male affinities and skills.

- **They do not connect the STEM disciplines with professions but with activities and objects.** They associate Science with experiments in a laboratory, Technology with work in computers, Engineering with building construction and Mathematics with its teaching.

- The children consider that the **four disciplines can be performed by both men and women.** However, some see Engineering as a masculine activity.

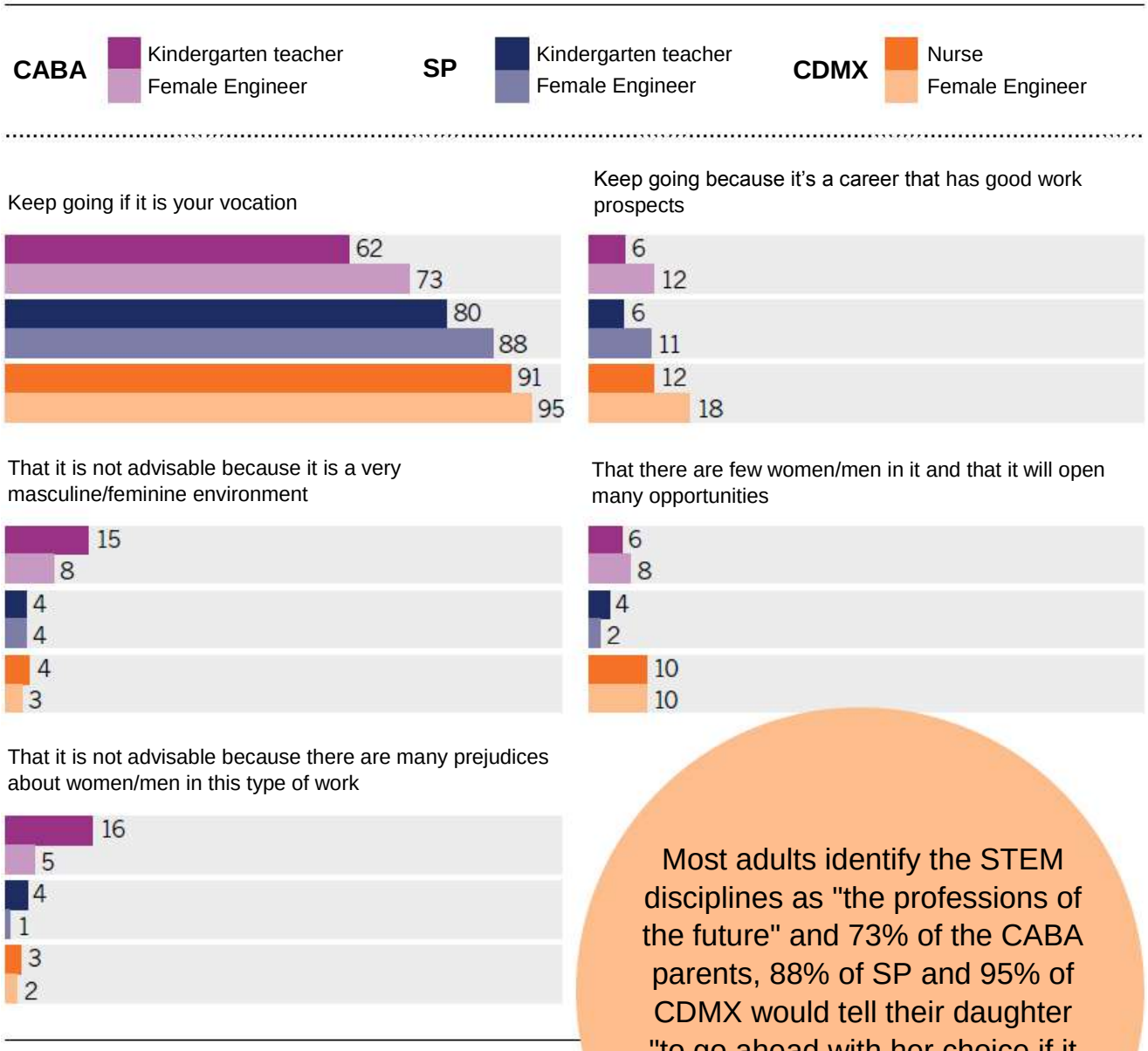
- **Those dedicated to Science, Mathematics and Engineering are seen as very intelligent and important people, but technologists are not attributed these characteristics.** They are associated with ordinary people who are fundamentally entertained by the use of technological devices.

4.2 What do parents say?

Most would encourage their children to follow their likings, regardless of whether the career chosen is associated with the masculine world in the case of women, or the feminine world in the case of males. "Doing what you like" is considered a key to personal satisfaction and success at work. They emphasize the job opportunities that a STEM career would offer them and few of them would try to discourage the choice of their son/daughter based on issues related to gender stereotypes.

What would you say to a daughter if she tells you that she wants to study Engineering, such as electromechanics? And to a son if he chooses to be a kindergarten teacher or nurse?

In percentage.

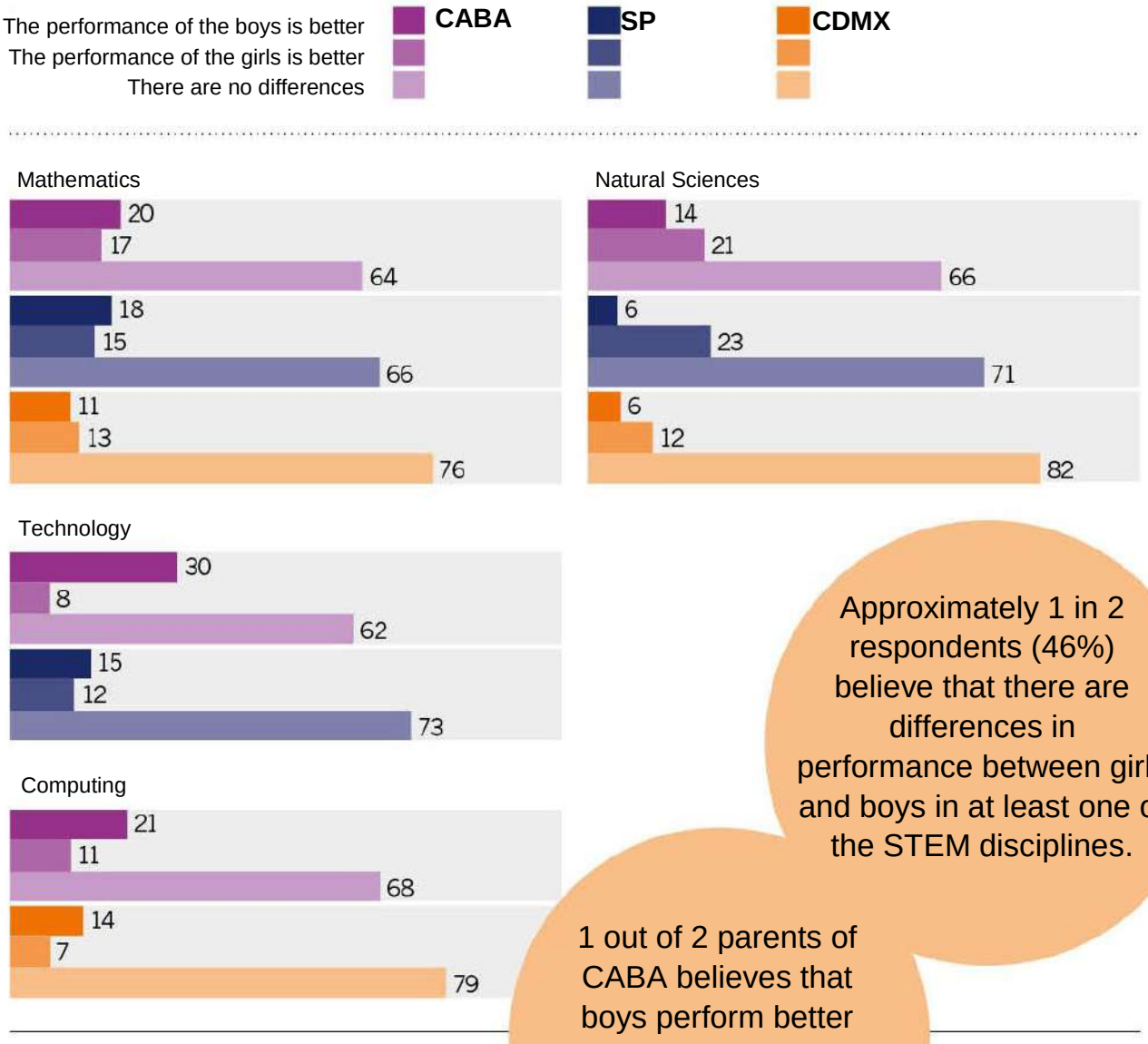


Most adults identify the STEM disciplines as "the professions of the future" and 73% of the CABA parents, 88% of SP and 95% of CDMX would tell their daughter "to go ahead with her choice if it is her vocation although they are male disciplines ".

In general, they consider that there are no differences in school performance between boys and girls. Among those who admit their existence, the idea prevails that men perform better in Computer Science and Mathematics and that girls excel in Sciences.

School performance of boys and girls, according to fathers and mothers

In percentage.



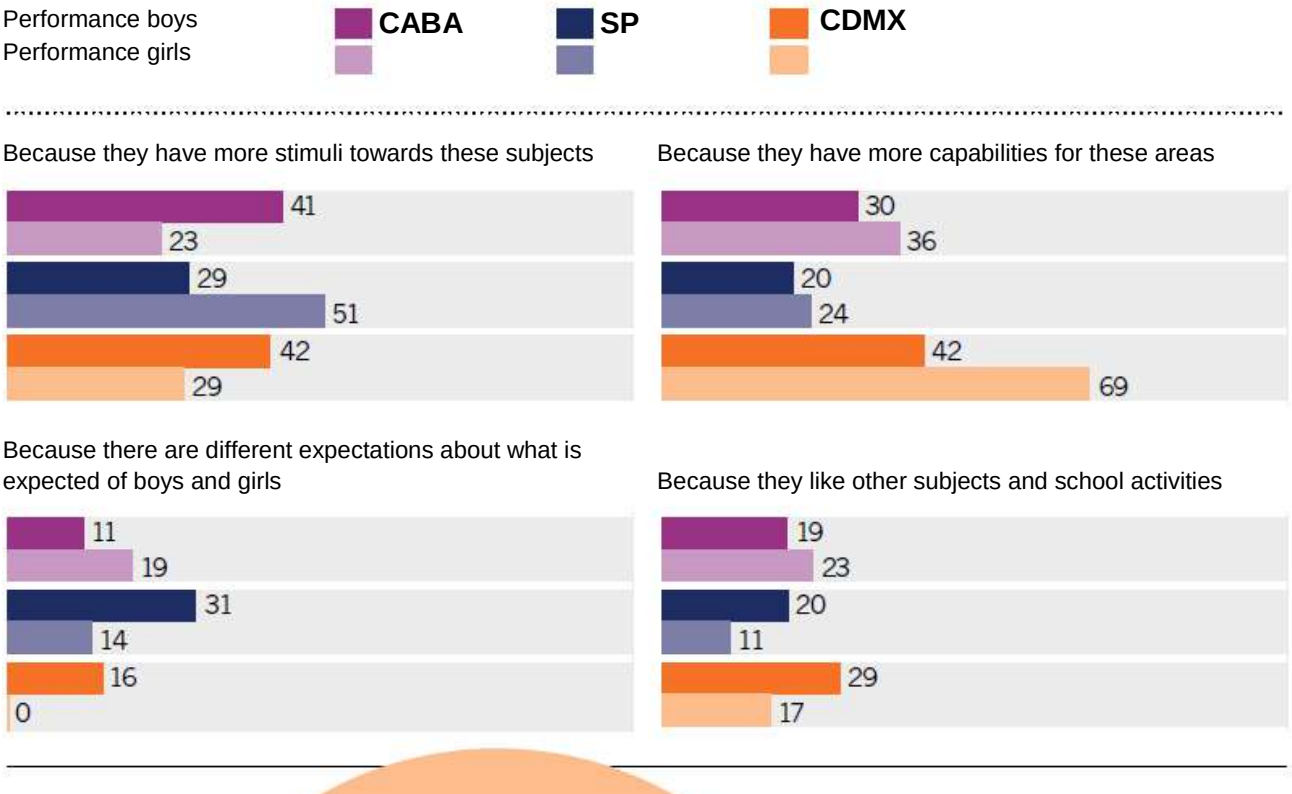
Approximately 1 in 2 respondents (46%) believe that there are differences in performance between girls and boys in at least one of the STEM disciplines.

1 out of 2 parents of CABA believes that boys perform better than girls in Technology and Computing.

The reasons that would explain these differences vary by city.

Why would girls and boys perform better? According to fathers and mothers

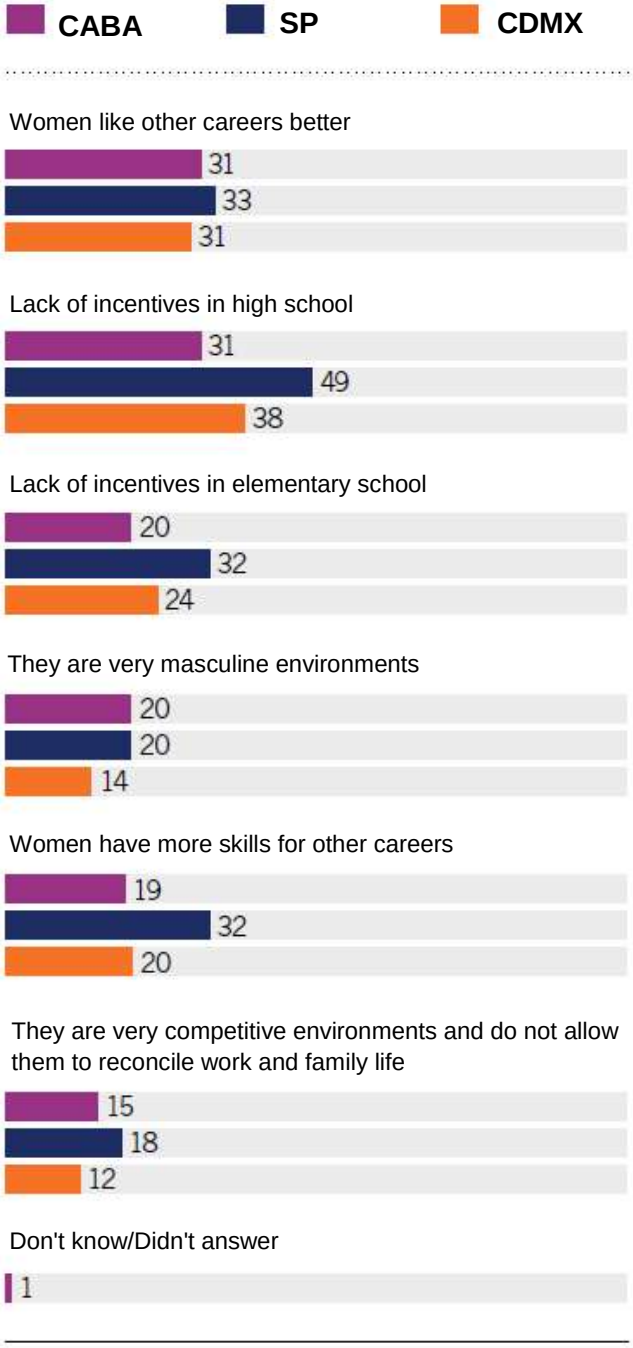
In percentage.



In CABA and CDMX, the argument prevails that **girls have more capacities** for an area and that **boys achieve better performance because they receive more stimuli from their surroundings**. In SP, this last statement is used to explain the good performance of girls, and in the case of boys, reference is made to the **expectations that fall on them.**

Why are there few women in STEM? According to fathers and

In percentage.



The majority points out that the **low participation of women in the STEM areas** is due to the fact that **they receive few stimuli in high school to be interested in these careers.** Secondly, they consider that this happens because they are not related to their likings and, thirdly, because they are not encouraged from elementary education.

The majority of fathers and mothers do not know precisely the STEM professions, but they affirm that, at a social level, they are highly valued and have more status than others. They admit that their study demands a lot of dedication and that those who work in them are very intelligent people, with skills for abstract and logical thinking.

They consider them “the professions of the future” and would like it if both their sons and daughters, if they wish, chose one of them. However, their greatest wish is that children are free to choose which career to follow.

They value, in particular, that their daughters choose careers that will allow them to gain autonomy both economically and personally. Many state that the image of the single male provider, the woman who is a housewife, and the gender mandates, are losing validity in a world that requires men and women to be trained in order to lead a productive and economically profitable life, to progress and have autonomy to make decisions.

They believe that "in society" the gender stereotypes that attribute greater skills to men for the STEM disciplines are part of the past and that there are no trades or professions reserved for women or men. Their discourses do not express explicit mandates or censures as in past ages.

Most feel proud when their children excel in school activities related to Mathematics, Computers and Science.

Some state that they try to promote the interest of both in this knowledge through outings, games and toys.

All of them admit that the use of technological devices occupies an important place in the lives of their children and they worry about controlling the time they devote to this activity and the contents they access. Some consider that boys have more skills for its use. This positioning is consistent with the social construct that associates males with technological creation. Studies carried out in the last decades point out that their persistence reduces the interest of girls in this discipline and is one of the factors that explain their low presence in careers related to computers (Bonder, 2016[5]).

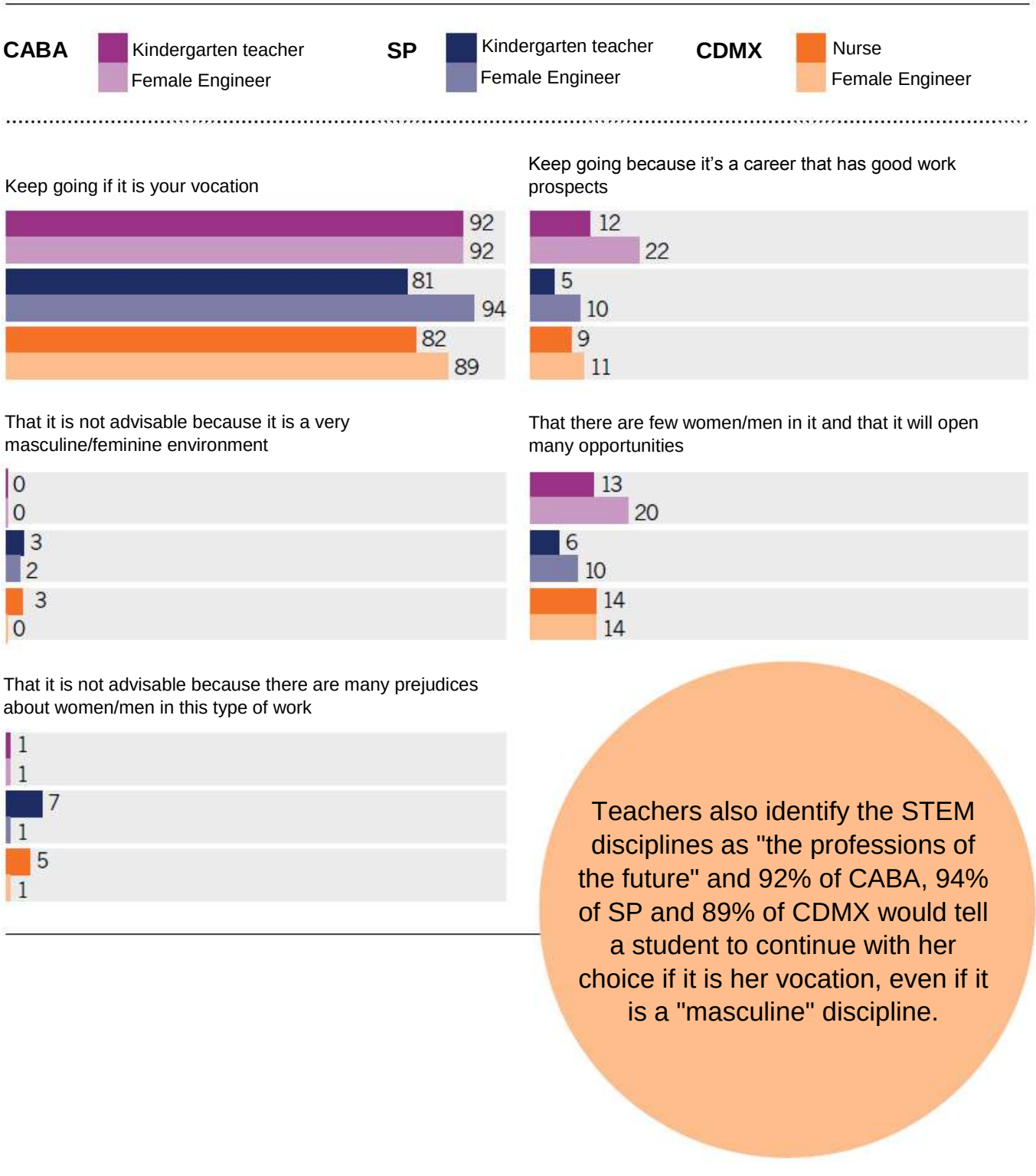
4.3 What do the teachers say?

Teachers **would encourage their students to follow their vocation regardless of whether the chosen career is associated, at a social level, with a particular gender.** Above all, they value the vocation for the profession. The percentage that would try to dissuade them with arguments related to gender stereotypes is not significant.

[5] Bonder, G. (2016). Those who said yes: women who study Computer Science in Argentina. FLACSO Argentina. Available in: https://issuu.com/catunescomujer.org/docs/inv_conaplu_bonder_resumen

What would you say to a female student if she says she wants to study Engineering, such as electromechanics? And to a male student if he chooses to be a kindergarten teacher/nurse?

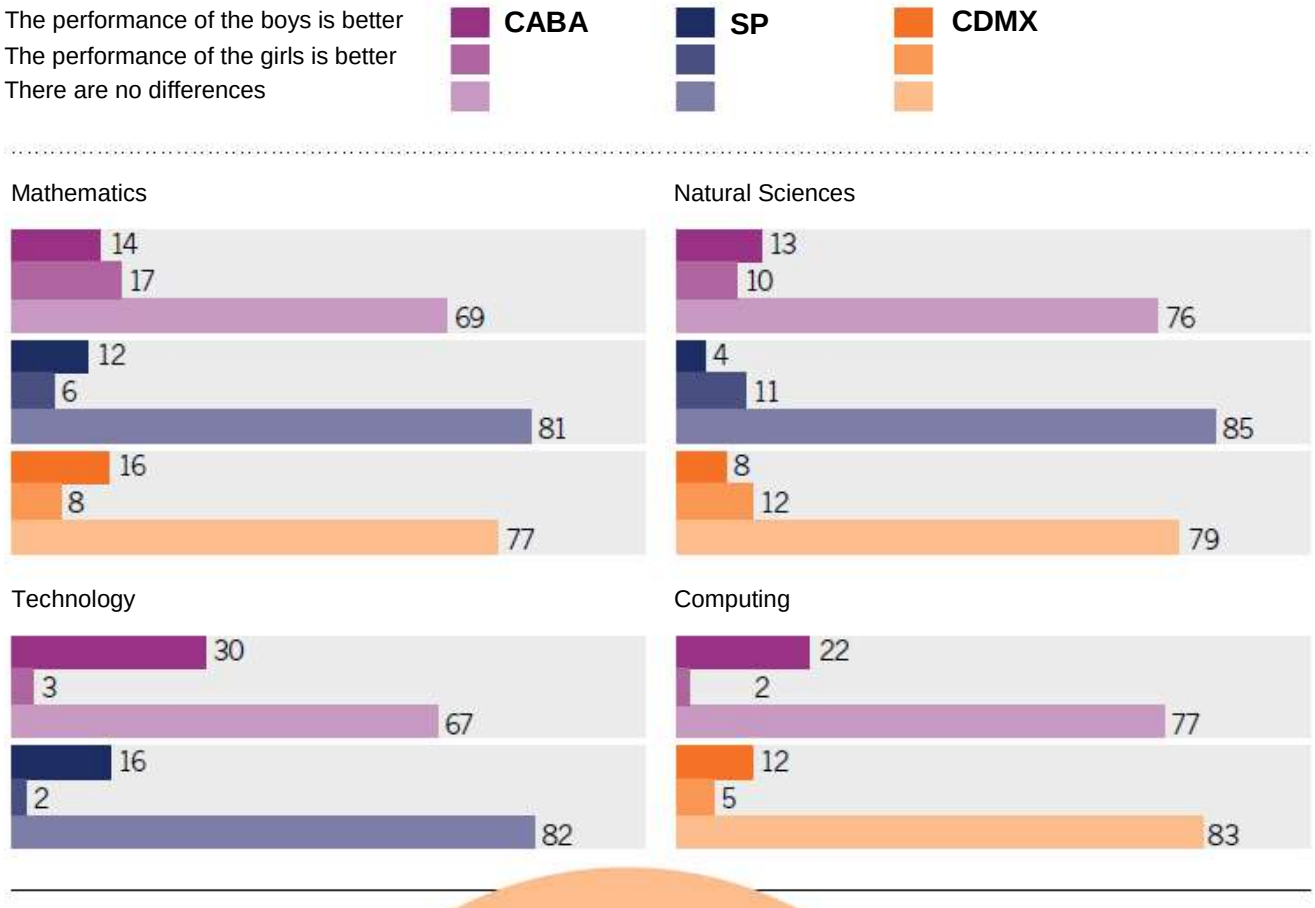
In percentage.



Teachers also identify the STEM disciplines as "the professions of the future" and 92% of CABA, 94% of SP and 89% of CDMX would tell a student to continue with her choice if it is her vocation, even if it is a "masculine" discipline.

School performance of boys and girls, according to teachers

In percentage.

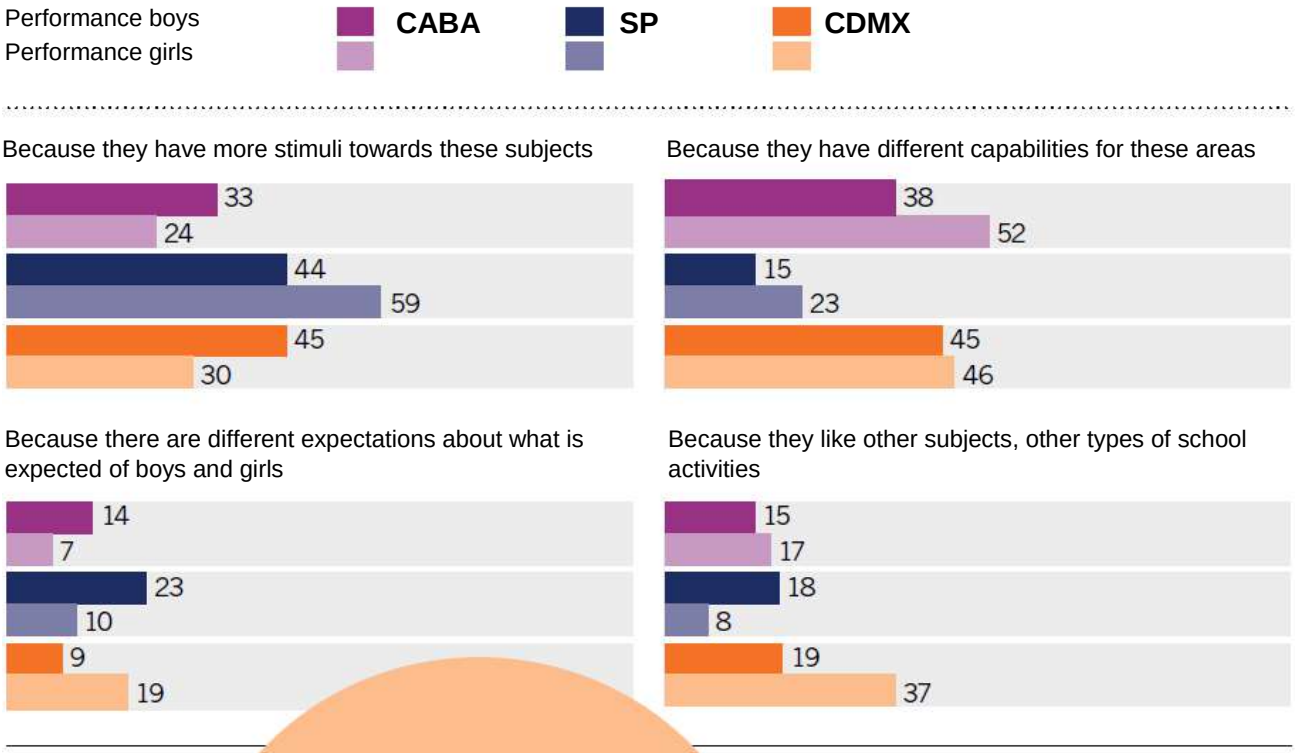


Most think that there are no gender differences in school performance in STEM areas. Among those who do, they point out that **men perform better in Computer Science and Mathematics and girls do better in Sciences.** CABA offers an exceptional panorama, the majority adjudicated better performance to the girls in Mathematics and to the boys in Sciences, Technology and Informatics.

From the point of view of teachers, boys outperform girls in computing. This opinion is consistent with some of the testimonies expressed by them in the focus groups. At a general level, it could be said that while the best performance of boys in mathematics is demystified, the construct that gives them more skills for computer science is reinforced.

Why would girls and boys perform better? According to teachers

In percentage.



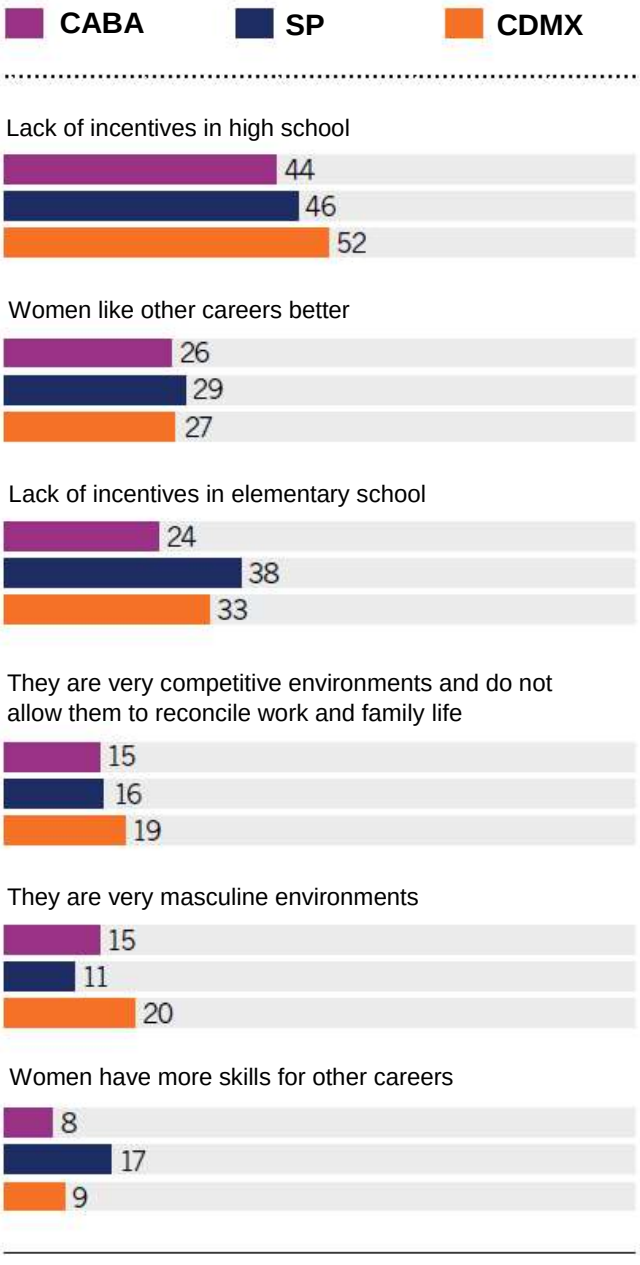
In CABA and CDMX, they explain that these differences are due to the fact that **they have more capacities for one of these areas.** In SP, however, they resort to the argument that **boys or girls receive more stimuli from their environments.**

To explain the **low female participation in STEM**, they focus on three arguments: **the lack of incentives from secondary education, elementary education and that women like other types of careers.**

Few people consider that women are a minority in the STEM field because it is a predominantly male field.

Why are there few women in STEM? According to teachers

In percentage.



Teachers recognize that the STEM professions are highly valued at the social level, that their study demands a lot of effort and that, if they are determined, both women and men can perform in these fields. Some recognize, however, that women face greater obstacles to progress in these disciplines.

They admit that stereotypes persist that tend to associate STEM with masculine abilities, but they do not subscribe to this position and consider that affinity (or liking) for these areas plays a fundamental role for successful professional choices.

Regarding differences in school performance and STEM subjects in particular, opinions vary. In relation to Mathematics, they are divided between those who think there are no differences and those who believe that males have more skills for these areas. In general, they agree that girls excel in Language and one of their explanations, based on gender stereotypes, is that this happens because girls are neat, calm and detail-oriented.

They emphasize the fluid relationship that boys and girls establish with ICT, although in some cases they state that boys are more active in the use of these devices. **They also point out that the use of these tools favors the interest and learning of the STEM areas.**

They recognize that the school is a favorable environment to stimulate the interest of children in STEM and some explain that they try to do so by incorporating playful learning strategies. For them, the important thing is that both boys and girls are able to learn all these disciplines without gender distinctions.

Some recognize that they need to have more training to implement new strategies for the teaching-learning of STEM subjects. They also state that it would be convenient to extend the time commitment for these subjects.

5 | What do the findings tell us?

The change has already begun. In the adult world, as well as in the children's vision, the division between male and female activities begins to belong to the past. STEM activities and professions are "for both".

A predominant tendency among adults is the acceptance and valuing of the freedom of choice of boys and girls by areas of knowledge and by future professional options, even those that contradict what has been historically attributed to each gender. Have gender stereotypes and biases disappeared from their cultural conceptions?

Undoubtedly, no. But there are significant changes with respect to previous eras in the discourses on gender differences in the fields of studies and careers; especially in how they communicate and relate to their

children on issues that have to do with their freedom, autonomy, transmission and obedience to parental norms and expectations.

This vision is a sign of the era that speaks of the emergence of a new childhood, a new parenthood and new visions of development in which the STEM disciplines are seen as the careers of the future.

Children and their relationship with STEM

- The vision, habits and preferences of children speak of a generation that finds special satisfaction in experimentation, movement and play.

- The relationship they establish with STEM differs in each discipline. Technology is part of their life inside and outside of school, mainly to play but also to interact with other people. Although both genders use them frequently, from the adult viewpoint the belief still holds that males possess more skills and affinity with this activity

- They are in contact with Science, also in both spaces, through games and content that they access through television and Internet. When they perform these activities in their homes (without rules or time frames) they receive greater pleasure. Girls express more affinity with this subject.

- Mathematics, circumscribed to the school environment, is one of the disciplines that most tests the abilities of boys and girls. The stereotype that associates the skills of boys with this subject is slowly losing validity, although with variations according to local contexts, mainly due to the teaching methods that predominate in each one.

- It is often explained that Mathematics does not arouse girls' interest because, as they grow up, they believe that they are not able to solve problematic situations or that they will get worse grades, although the evaluations indicate that their performance in some contexts is superior or the same as that of the boys. The results obtained question this explanation, at least partially.
  Although adults do not perceive differences by gender in school performance, some believe that men have more skills for Mathematics and girls for Language. This is a fact that imposes the need to revise the belief that whoever stands out in Language cannot do it in Mathematics and vice versa.

Some steps that could contribute to materialize the freedom that adults crave for their children or students are the following:

- Abandon dichotomous postures
- Promote equal opportunities for men and women to strategically take ownership of Information and Communication Technologies (ICT);
- Question gender stereotypes, such as the one that gives males more skills for STEM disciplines;
- Link the learning of Science with the social problems and interests of boys and girls

Parents and teachers: vocation is the key to success

- The explicit mandates, the sanctions, the repression against the likings that the children express regarding playful activities, content or areas of learning or future elections, do not conform with the traditional gender stereotypes and the current way to exercise authority, at least in terms of preferences and choices of studies of children, in the contexts and sectors analyzed.

- The rhetoric about the dominant equality in the majority, the acceptance of the tastes or inclinations of children and the control parents/mothers have over the length of time of use of technological devices and the contents they access, show other ways of exercising parental roles. A way where the negotiation with children, the explanation of why they put a limit or assume a position that contradicts their desires needs to be justified and argued.

- Although children are still permeable to the expectations and values that are transmitted to them from the school and family worlds, other socializing agents and, especially, the early and direct access to ICT have a great influence on the formation of their subjectivities, desires, pleasures, knowledge, rights, visions about a changing future, unpredictable although attractive due to the wide range of options.

- In this framework, teachers are no longer the holders of all knowledge. Their students can be the ones who teach them. Possibly, this disruption of an order of knowledge based on the hierarchy of adults over childhood explains why it is difficult for them to strategically take ownership of teaching technologies, abandoning their traditional role as unique and valid transmitters of knowledge.

- Another factor that seems to explain a flexibilization in the generational transmission of gender stereotypes is the parents' concern about the future employment of both genders. They evaluate the future of their sons and daughters taking into account the labor market, their present and possible future. This is not only associated with males, as it could have happened in other eras, but it is a factor that they also consider when evaluating the decisions of their daughters. Despite this, many do not identify that the conditions for the development of women and men in various areas, and especially in STEM, are unequal and that barriers persist that limit the professional development of women.

Men face more restrictions to break with traditional gender stereotypes than women, since their masculinity is questioned.

- However, in this discourse that emphasizes freedom and equality there are nuances. Although the majority recognizes significant changes in the participation of women in all spheres of society and accept them, they show that they are attentive to them maintaining certain traits or behaviors indicative of "femininity". In other words, they accept that they participate in traditionally masculine areas but without masculinizing themselves.

- In relation to the above, it is perceived that this situation does not extend equally to the male population; they face more restrictions or possible penalties when breaking with traditional gender stereotypes. This difference may be linked to the fact that the advance of women is perceived as a social conquest; while, on the other hand, for males, their masculinity is questioned.

- This discourse also manifests features of the so-called "meritocratic equality" based on individualism and meritocracy. They do not oppose elections that question previous mandates, because they replace them with current conceptions of the autonomous individual, whose achievements depend on their ability, entrepreneurship and/or diligence, the supposed existence of equal opportunities in contemporary society and therefore the discrimination of gender as something of the past, for which it would not be necessary to intervene in any aspect. If women make incorrect choices and they do not achieve the expected results, it would be their responsibility.

Freedom, autonomy and equality are the keys of the discourse of adults in relation to the professional future of children. However, stereotypes and gender bias persist that condition this desire. Their improvement not only benefits them individually and in the exercise of their citizenship, but also contributes to a more inclusive, diverse and fair scientific and technological

development.

6 | Recommendations

For the educational field:

- Provide girls with resources to develop “gender lenses” that allow them to notice possible situations of discrimination (explicit and implicit) that they may face in their training and work paths if they opt for a career linked to the STEM field. Encourage them to design strategies for their improvement.

- Generate educational policies aimed at having men and women have equal opportunities and conditions to train in STEM careers.

- From the elementary and high school levels, promote a method of STEM learning that favors experimentation and creativity, and is oriented to finding solutions to problems that are part of the social environment of both genders and arouse special interest. Take advantage of the knowledge and orientation of the Tinkering movement.

- In the curricular contents, teaching strategies and learning materials, include positive images of women and girls in these fields that encourage their participation in the creation in STEM. Make visible the role of women in the history of science and technology and in the present (in particular of their countries and if possible of their communities) and the gender inequalities that they faced during their careers.

- Ensure that the methodologies, indicators and content of performance evaluations [6]of children are not based on gender biases or stereotypes that may negatively affect confidence in their abilities in these issues.

- Incorporate in the practical activities the use of technological resources and equip the institutions with instruments and other materials to carry out scientific experiments. Motivate children to use them in equal conditions.

[6] The evaluation of STEM performance in general is not only influenced by the cognitive abilities of the students, but also by the non-cognitive factors related to the procedures and resources that are used, the perceptions of the teachers and the students about the ability, also psychological factors such as motivation and anxiety during the exam, especially when that exam is about performance in math.

- Include in teacher training the conceptual foundations, methodologies and practical examples to integrate the gender equality approach in STEM learning.

For teachers:

- Encourage teachers to review their attitudes, beliefs and behaviors in their interaction with students and reflect on the effects they may have on their future choices. Avoid the reproduction of representations about the STEM disciplines that show them as difficult, reserved for a few, so that children feel motivated to opt for them.

- Use educational materials (textbooks, virtual learning environments, for example) and other resources aimed at children (video games, documentaries, hypermedia content) that do not transmit messages and images that perpetuate gender stereotypes and assign an equalizing environment to the interests, capacities and motivations of girls and boys with respect to the STEM disciplines.

- Help teachers detect and problematize the persistence of gender inequality based on stereotypes, both in educational environments (curricular content, pedagogical practices, materials, etc.) and in social environments. Consider the cross-sectional nature of the disciplines, promoting the teaching of STEM in all opportunities with students.

- Encourage interdisciplinary learning in STEM through annual classroom projects that favor interaction with other members of the educational community (children and teachers of other grades, school authorities and parents).

For families:

- Motivate the development of skills in girls and boys alike, reaffirming and stimulating their self-esteem and breaking patterns and hegemonic gender models that traditionally limit them.

- Do not encourage divisions of games or toys, clothes or colors, activities or attitudes to be considered "boy's" or "girl's".

- Promote a critical view on the consumption of cultural content for children and with a gender perspective, discussing representations and assigned roles.

- Include family visits and cultural activities to visit science museums, planetariums and support experiences that integrate science and technology with group proposals for collaborative learning.

- Encourage children to access information about the different models of being a man and being a woman. Make visible the contributions of women in the different fields of science and technology. For example, through the telling of biographies.

- Ensure that girls and boys have equal opportunities to use the electronic devices available at home.

- Verify that the applications accessed by children do not transmit gender stereotypes and promote the use of those that offer them challenges.

- Take a critical look at the gender stereotypes that are naturalized in homes. Include boys and girls in this questioning.

- Incorporate recreational activities related to science and mathematics in the everyday environment.

- Avoid viewing STEM subjects as “difficult” or “only for smart people". Do not perpetuate an image that assigns one gender more capabilities on any of these disciplines.