Gender equality in Ceibal's STEM ecosystem

Ceibal

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The insertion of more women in the fields of science, technology, engineering and mathematics (STEM) opens up more opportunities for both national and individual development. As substantiated in the first section of this publication, this happens because the insertion increases the number of people working in a booming industry, generates more diverse work teams, and provides well-paid, flexible jobs. Nevertheless, over the last years we observe that in Uruguay, on average, very few women work in these fields, creating an untapped potential for the country in wealth generation and a wasting, on the part of women, of the advantages offered by the field.

Ceibal has always been committed to fostering strategies to promote gender equality and, as such, this commitment is enshrined in the organization's Quality Policy. Specifically, one of the objectives of the Ceibal 2021-2025 Strategic Plan is to increase the participation of girls in STEM programs to at least 45%. Accordingly, we have conducted programs and specific actions to this end. Ceibal has a varied STEM offer: from delivering programmable boards for the development of computational thinking in the curriculum to having national and international robotics competitions. Consequently, actions to promote the participation of girls are also varied and may span from the way in which a program is publicized to its design characteristics (for example, when an activity is voluntary for a group or student level, deciding whether it is mandatory to have mixed work groups.) To assess the efficacy of these actions, correct those that do not work and replicate those that do, we developed a dashboard of indicators that allow us to visualize their effects. This publication details the way in which this dashboard was created, and the method used to calculate the gender gap in the STEM ecosystem of Ceibal, and additionally discusses what was learned through the process, as well as recommendations arising from international experiences.

I hope this publication will contribute to raising awareness on the importance of eliminating the gender gap in the STEM area and on the use of indicators and data visualizations for decision-making processes. In the past 15 years, we have learned a great deal while implementing Ceibal, and this work aims at sharing what we have learned with other institutions facing challenges similar to ours. We believe that by showcasing the specific actions that led to an increase in the participation of girls in STEM programs, we may contribute to building knowledge in this area, and find solutions to increase the participation of women and girls in STEM fields.

Fiorella Haim
General Manager, Ceibal

Ceibal never ceases to amaze. Uruguay has been an example for the region, integrating technology in primary and secondary education through a successful platform that committed to learning in digital environments and universal access to technology as a means to democratize knowledge.

This is why UN Women celebrates that the educational public policies of Ceibal remain at the forefront of innovation, as seen now with the creation of a dashboard of indicators of gender in STEM for informed decision-making. This study on "Gender equality in Ceibal STEM ecosystem" consolidates data reported by each unit responsible for the STEM programs, resources or devices making gaps visible. This input is invaluable when improving or designing actions advocating for a greater women inclusion and participation in STEM, a field experiencing an accelerated, growing demand for talent.

Guaranteeing the availability of data disaggregated by sex, as well as conducting a gender analysis of data is a significant step to consolidate public policy and strategies that promote a change in stereotypes, social standards, prejudices and roles, factors that affect both the choice of seeking education in STEM fields and the decision to continue and move forward in a Science and Technology career path.

Providing equal opportunities for women to grow and prosper in STEM fields improves the economic security of women, ensures diversity and talent in the workforce, helps reduce the gender wage gap and prevents biases in these fields and in the products and services provided. Uruguay faces great long-term challenges related to its advanced demographic transition, the education gaps accentuated by socioeconomic strata, territorial inequalities, among others. In addition to this, we face the gender gaps that still prevail in all spheres of society and which, in addition to being a fundamental human rights and social justice issue, also relate to the opportunities the country squanders by not taking advantage of female talent. The more women enter the labor market in quality jobs and decision-making positions, the stronger we shall be as a society and the better prepared we will be to face the future.

Development is impossible without equality: it is imperative to move forward with the transformation of gender relations to achieve sustainable development, as endorsed by Ceibal's policy to promote gender equality at the institutional level. Undoubtedly, these strategies contribute to goal 5.b of the Sustainable Development Goals of the 2030 Agenda that seeks to "Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women."

UN Women celebrates this initiative that contributes to our joint efforts to advocate for future generations of girls and women to participate and remain in the field of STEM.

Magalena Furtado
Director of Programs for UN Women in Uruguay

Executive summary

The objective of this work is to develop a dashboard of gender indicators in STEM.

The underlying **idea** is to allow for informed decision-making backed by empirical evidence.

Based on international best practices (EIGE, 2016, 2017a, 2017b; OECD, 2015; UN Women, 2020; Schiebinger et al., 2011-2020; UNECE, 2013; UN, 2016,2020; UNESCO, 2015,2017), a **conceptual framework** specifically designed to study gender equality in STEM among children and teenagers was developed.

Three dimensions of analysis were identified:

I - Access to STEM resources and opportunities.

II - STEM knowledge acquisition through teaching and learning processes.

III - Occupying responsibility and decision-making roles.

Additionally, this document presents a theory of change:

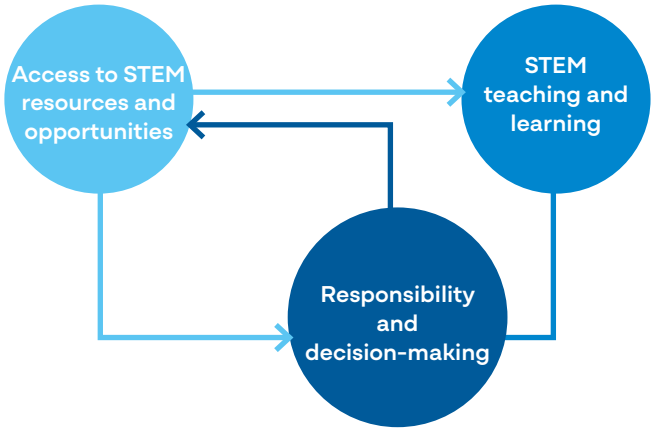


Fig. A: Theory of change, Ceibal.

This document maps Ceibal ' s STEM ecosystem as it is not possible to isolate the effect of programs providing access to devices from those of digital tools that enhance learning.

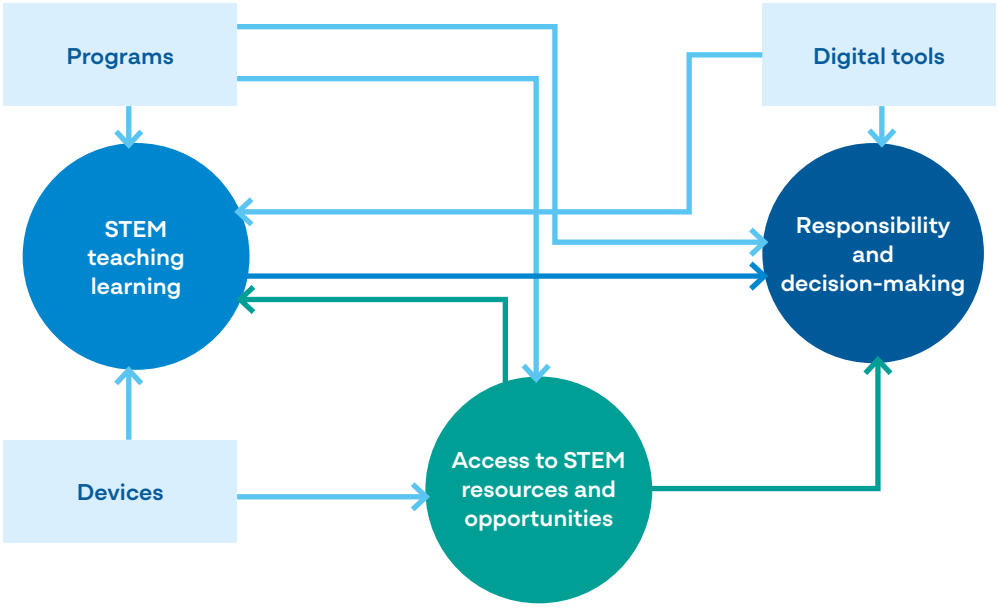


Fig. B: Mapping the STEM ecosystem, Ceibal.

Ecosystem	Name	Opportunities and resources	Teaching learning	Decisions and power	Target population	Since	Indicator: gender gap
Device	ceibalitas (primary education)	x	x		Students	2007	Delivery
Device	Micro:bit board	x	x		Students	2018	Delivery
Device	Robotics kits	x	x		Education center		
Device	Drones	x	x		Education center		
Device	3D printers	x	x		Education center		
Device	Physico-chemical sensors	x	x		Education center		

Ecosystem	Name	Opportunities and resources	Teaching learning	Decisions and power	Target population	Since	Indicator: gender gap
Tool	CREA		x		Students and teachers		Comments mean, deliverables mean, visualizations mean
Tool	Mathematics platform		x		Students and teachers	2013	
Tool	Minecraft Education		x		Students and teachers	2020	
Tool	Biblioteca País		x		Students and teachers	2018	
Tool	Videogames		x		Students and teachers		
Tool	Valijas		x		Students and teachers		
Tool	Mathematics training		x		Teachers	2022	
Program	Ceilab		x		Education center	2017	
Program	Jóvenes a Programar (JaP)	x			Students	2017	Interest in JaP
Program	Jóvenes a Programar (JaP)	x			Students	2017	Completing a worksheet
Program	Jóvenes a Programar (JaP)		x		Students	2017	Graduation
Program	Jóvenes a Programar (JaP)			x	Students	2017	Job placement SIL
Program	Computational thinking	x	x	x	Students	2017	Enrollments
Program	Computational thinking	x	x	x	Teachers	2017	Enrollments

Ecosystem	Name	Opportunities and resources	Teaching learning	Decisions and power	Target population	Since	Indicator: gender gap
Program	Computational thinking	x			Teachers	2020	Perception survey: soft skills
Program	Computational thinking	x			Teachers	2020	Perception survey: language
Program	Computational thinking	x			Teachers	2020	Perception survey: mathematics
Program	Computational thinking	x			Teachers	2020	Perception survey: computational thinking
Program	Bebras challenge		x		Students	2020	Matches median
Program	Bebras challenge		x		Students	2020	Student participation
Program	Robotics, programming and videogames program Olympics	x			Students	2020	Applicants
Program	Robotics, programming and videogames program Olympics		x		Students	2020	Classification
Program	Robotics, programming and videogames program Olympics		x		Students	2020	Finalists
Program	Robotics, programming and videogames program Olympics		x		Students	2020	Winners
Program	Science sessions	x			Teachers	2021	Enrollments
Program	Mathematics meeting	x			Teachers	2022	Enrollments
Program	Scientists in the classroom	x	x	x	Education center	2018	Enrollments

About the **contents** of the document:

- Ceibal has the policy of promoting institutional gender equality, which is actively supported by its senior management.
- It has a holistic approach. Active policies are in place to increase the number of girls and women who wish to join in the three analysis dimensions with different degrees of intensity.[1]
- Since devices are universally distributed, there is no gender gap in the access to resources.
- Ceibal promotes gender equality in STEM through concrete actions.
- The institution has a comprehensive strategy to disseminate and share good practices in gender equality:
  - Developing gender-based statistics.
  - Collecting statistics that include groups not identified with the biological sex.
  - Guidelines to promote the active participation of girls and women in STEM activities.
  - Using language to include everyone.
  - Producing data in real time, with relevant information for decision-making.

[1] It is not just about women participating in this area, but it is also about understanding and eliminating obstacles preventing women from choosing careers in STEM.

Glossary

This glossary makes it easier to understand the ideas expressed in the document:

Glossary	Definition
Prescriptive analysis	The prescriptive analysis collects data from descriptive and/or predictive sources and applies them to the decision-making process, providing a roadmap on directions to follow.
Gap	The gap is calculated as the difference ratio between a target population and the total. For example: the gender gap is calculated as (men - women) / (men + women). The gender gap is an indicator. Often, it is multiplied by 100 to express it as a percentage.
Ceibal	Ceibal is the education innovation center of Uruguay with digital technologies and at the service of education public policies.
Equality	Equality is an ethical guiding principle associated to the idea of justice. Under this concept, the center attempts to meet the needs and interests of people who are different, especially of those who are at a disadvantage. The concepts of equality and equality send different messages. Equality is an ethical guiding principle focused on aspects to be satisfied among a specific sector of the population. Equality is a human right of all people, and it is not subject to specific needs. Source: https://campusgenero.inmujeres.gob.mx/glosario/terminos/equidad
Gender	Socio-cultural and self-perception construct that brings together roles, behaviors, activities and attributes that a specific society in a specific time deems appropriate for human beings of each sex. Gender is not a binary variable.
Gender equality	Fundamental human right enshrined in Article 1 of the Charter of the United Nations.
Indicator	An indicator is a statistical variable with a benchmark which can be compared in time, and which may be compared with that of other populations.
Parity	Parity is not an affirmative action or a goal in and of itself, but rather a measure for the distribution of opportunities, decisions and power in all spheres of life. Its implementation entails transforming institutions, social life and family life so that men and women have equality. Source: https://campusgenero.inmujeres.gob.mx/glosario/terminos/paridad

Glossary	Definition
Proportion	Proportion is calculated as the quotient between a group and a total. For example: the reason for girls to be in a course if calculated as girls / (girls + boys). The proportion is an indicator.
Prospective	Referring to the future. Set of analysis and studies conducted to explore or predict the future in a certain area. Source: Real Academia Española.
Reason	Reason is calculated as the quotient between a group and its complement. For example: the reason for girls in a course is calculated as girls / boys. Reason is an indicator.
Sex	Biological trait of human beings. Binary variable with two attributes (feminine / masculine).
Horizontal segregation	Separation in job positions based on gender. For example: women taking care of children.
Vertical segregation	Vertical segregation in the workplace is a situation in which people of a specific gender, race or age cannot attain the highest positions in a specific area.
Segregation in the labor market	Workplace segregation by gender is multi-causal (economic, domestic and cultural causes) and plays a role in maintaining other inequalities in the labor market (participation, salaries and promotions, among others.)
STEM	Activities in fields: 05-natural sciences, mathematics and statistics; 06-information technologies and communication; 07-engineering, industry and construction, as the international classification by the UN.

Introduction

The objective of this work if to produce a dashboard of gender indicators in Ceibal's STEM ecosystem.[1]

The **dashboard of gender indicators in STEM** (available in the Results section at the end of this document) describes and provides empirical evidence on the scope and coverage of the programs, digital tools (resources), platforms and STEM devices (STEM ecosystem) that Ceibal offers students and teachers, with a focus on gender equality.

While designing and building the dashboard of indicators, an **methodology of measurement and analysis was designed** to establish connections and chains of effect between the perceptions and stereotypes of people (students and teachers), acquire STEM knowledge and take on responsibility and decision-making roles.

By using this methodology, this work **maps Ceibal's STEM ecosystem** and allows for the **dashboard of gender indicators** to quantify **gender gaps** in the access to resources and opportunities, STEM teaching and learning and in the access to responsibility and decision-making roles in a systematized, orderly manner.

Thirdly, having a **set of visualizations** on the gender gap allows for analyzing data, making decision and arriving at **conclusions and recommendations** to actively promote gender equality in the STEM area.

Ceibal is an innovation center for education technologies that promotes equality and equal opportunities.

Ceibal is also a leading organization in the design and implementation of innovative programs incentivizing primary and secondary school students and the youth to join STEM programs by identifying the best policies to achieve gender equality, beginning with the design and calculation of indicators on the subject.

[1] As per the international classification, STEM fields comprise: 05 - **Natural sciences, mathematics and statistics; 06 -Information technologies and communication; 07 - Engineering, industry and construction** (UN Women, 2020.)

1.1 Structure of the document

This document is made up of three main sections.

The first section discusses the importance of STEM fields for women, as well as the significance of making decisions based on empiric evidence.

The second section of the document describes the measuring methodology used, maps the STEM ecosystem in Ceibal and presents the dashboard of gender indicators in STEM.

The third section of the document describes the main results and recommendations to foster gender equality in STEM (Fig. C.).

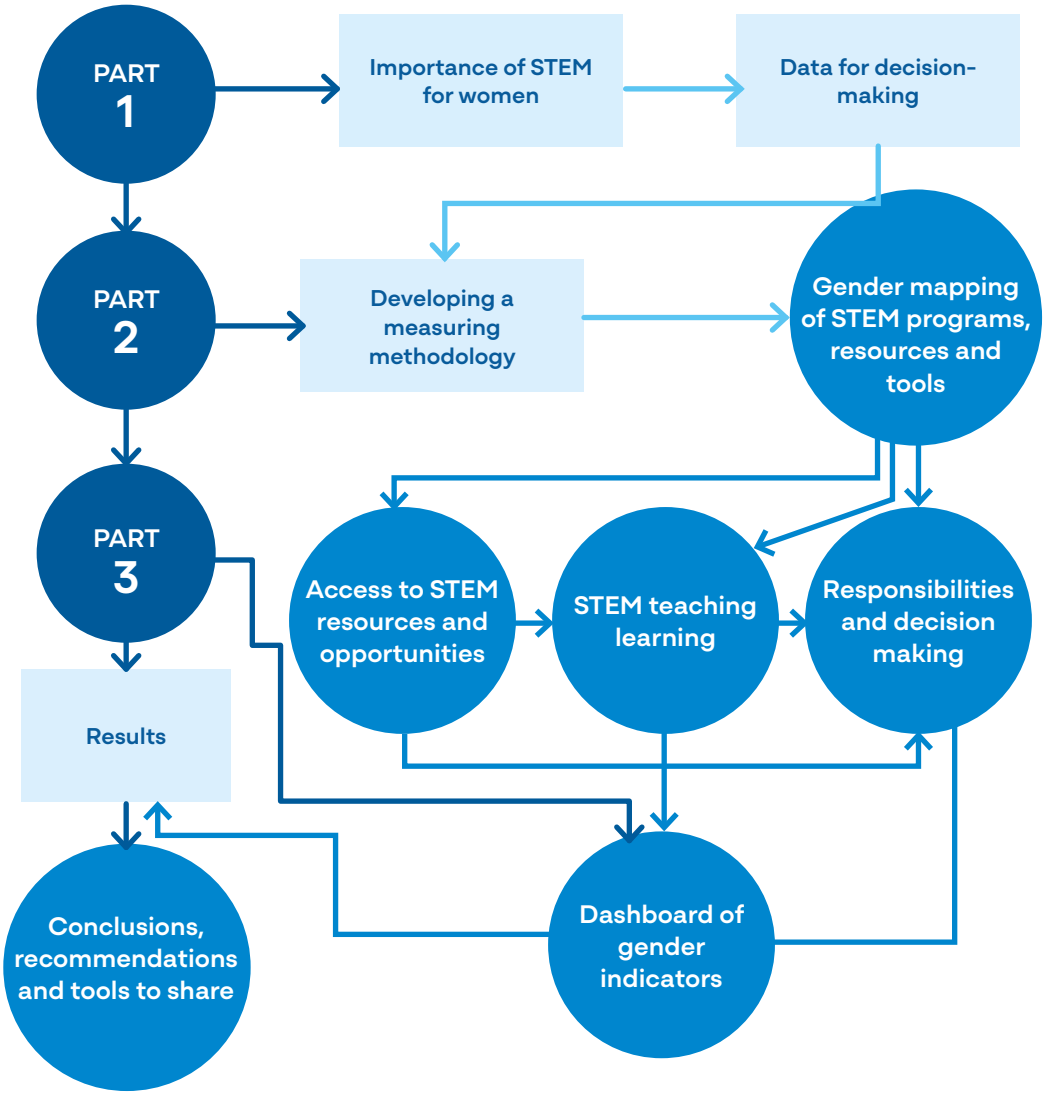


Fig. C: Structure of analysis

Part 1

- The importance of STEM areas for women and the economy
- Data and indicators for decision-making

The importance of STEM fields for women and the economy

This chapter describes the importance of STEM fields to guarantee the exercise of the fundamental rights of women, reviews the connections between STEM fields and their development, and briefly describes the Uruguayan case.

The importance of STEM fields for women and the economy

In addition to outlining the relationship between STEM fields, women's economic independence, and the expansion of the economy as a whole, this section discusses the significance of STEM fields in the exercise of women's fundamental rights.

Gender equality is a fundamental human right enshrined in Article 1 of the Charter of the United Nations in 1948.[1]

To achieve gender equality, it is necessary to guarantee that access to quality education and health, as well as to economic resources and the participation in the political life of a community, be equal for girls and women and for boys and girls.

It is also fundamental to achieve equal opportunities to access job positions and leadership and decision-making roles at all levels.[2]

For women

Time-use studies reveal that women, who tend to bear the major burden of household duties, have fewer hours per day available for leisure than males (caring for dependents, feeding tasks and cleaning the house). Due to the unequal distribution of household duties, women have fewer hours available for paid labour, which reduces their financial independence and jeopardises their fundamental human rights.

The information technology industry is showing an increasing demand for talent, which makes STEM careers a part of the future of work.

[1] https://www.un.org/es/about-us/un-charter/chapter-1

[2] https://www.un.org/es/global-issues/gender-equality

Careers in STEM provide **financial autonomy**. There are many employment opportunities and highly productive jobs provide higher salaries than those in other sectors. According to data from the UNESCO Institute for Statistics quoted by UN Women (2020), on average, salaries in the STEM area are 66% higher than those in other sectors. In Uruguay in 2017, STEM salaries were four times higher than the minimum wage (*JaP*, "Executive Summary", 2021.)

Despite these favorable perspectives, boys and girls tend to choose subjects based on traditional gender roles. When **choosing** a pathway in high school (Year 5), 40% of women choose the sciences pathway, while in Year 6 only 34% choose the physics-mathematics pathway (*ANEP*, 2019).

This education gap is later translated into the labor market.

The lack of diversity in STEM careers has implications for career progressions, as it hampers promotions and decreases the likelihood of being promoted to decision-making positions (Sierminksa and Oaxaca, 2021.) Women tend to be overrepresented in the informal sector, underemployment and in unpaid work (UNECE, 2013).

Gender equality is an ethical guiding principle, is associated to the idea of justice and seeks to meet the needs of disadvantaged persons or groups.

The concepts of equality and equality entail different messages.

Equality is a human right all people have, and it is not subject to specific needs. Equality is an ethical guiding principle associated to the concept of justice. Promoting gender equality contributes to achieving gender equality.

For the economy as a whole

Labor market

Increasing the participation of women and girls in STEM careers is **beneficial for the economy as a whole**, since currently many jobs are not being performed due to lack of trained workers.

Including women in STEM fields increases the **supply of human resources available**. A study from the European Union shows that including women in sectors with a demand for talent could increase productivity by up to 25% (UN, 2016.) Women make up half the population yet hold less than 20% of all management positions. Wasting this talent is **inefficient for the economy**.

[3] https://eige.europa.eu/publications/economic-benefits-gender-equality-eu-how-gender-equality-stem-education-leads-economic-growth

Shedding light on underrepresented activities

Giving women a voice as economic, political and social stakeholders can change political options and make institutions more representative of diverse voices (UNECE, 2013; UN, 2016; Sierminksa y Oaxaca, 2021)[4]. An example of this is the calculation of the gross domestic product (GDP.)

In the **economy**, we see that **rents are allocated in the GDP, but domestic work is not**. Homeowners are often men, and it is women who perform domestic work. Since half the population is left out when designing measuring methodologies, the **activities of this absent group are disregarded**.

Health

Giving women a voice provides notoriety for particular issues, which allows for **having a wider set of solutions available**. The COVID-19 pandemic showed once again the lack of specific studies on the effects of the vaccines on women and girls.

In **pharmacology**, between 1997 and 2000, ten drugs were recalled from the U.S. market given their life-threatening effects. Eight of them were **riskier for the health of women than for that of men** (U.S. GAO, 2011, quoted by *Schiebinger* et al., 2011-2020).

In **computer visualizations**, it is likely that facial recognition systems trained with biased data sets may not recognize women as well as men or people with darker skins as well as people with lighter skins, which means women with darker skins may not be recognized at all.[5] It is likely that facial recognition may also not be able to identify transgender people, especially while in transition. If proper male and female cells, tissues and animals are not used in basic research, it may yield incorrect results.[6] Source: *Schiebinger* et al., 2011-2020.

In **Engineering**, for example, considering short men (many women, but also many men) in safety attributes tests in vehicles decreases the seriousness of injuries caused by car crashes.[7]

[4] For example, including the work of caretakers for dependents in **urban planning** may improve the efficiency of the transportation system, since most people using public transport are women and it is more likely for them to make "consecutive" trips, for example, from school to work, from school to the grocery store and then home (Criado-Pérez, 2019).

[5] http://genderedinnovations.stanford.edu/case-studies/facial.html

[6] http://genderedinnovations.stanford.edu/case-studies/stem_cells.html

[7] http://genderedinnovations.stanford.edu/case-studies/crash.html

Intergenerational benefits

Benefits can also be intergenerational. Women with more education and control over the resources of their households have spending patterns beneficial to the current and future life of their children (UN, 2016.)

Evidence shows that parents who are more engaged in caring for their children are happier, live longer, and that their children are healthier and do better in school (Ñopo, 2020b.)

International obligations on human rights call for tending to and covering national statistics on men and women, since specific gender and reproductive roles give way to different experiences, needs and priorities (UNECE, 2013.)

Article 5 of the Convention on the Elimination of All Forms of Discrimination against Women (1981) provides that:

> States Parties shall take all appropriate measures:
>
> **A.** To modify the social and cultural patterns of conduct of men and women, with a view to achieving the elimination of prejudices and customary and all other practices which are based on the idea of the inferiority or the superiority of either of the sexes or on stereotyped roles for men and women;
>
> **B.** To ensure that family education includes a proper understanding of maternity as a social function and the recognition of the common responsibility of men and women in the upbringing and development of their children, it being understood that the interest of the children is the primordial consideration in all cases.
>
> Source: UN, 1981

Diagnosis: why are there no women in STEM fields?

This diagnosis of why there is a low percentage of women in STEM fields groups reasons into two main categories: individual decisions and social decisions.

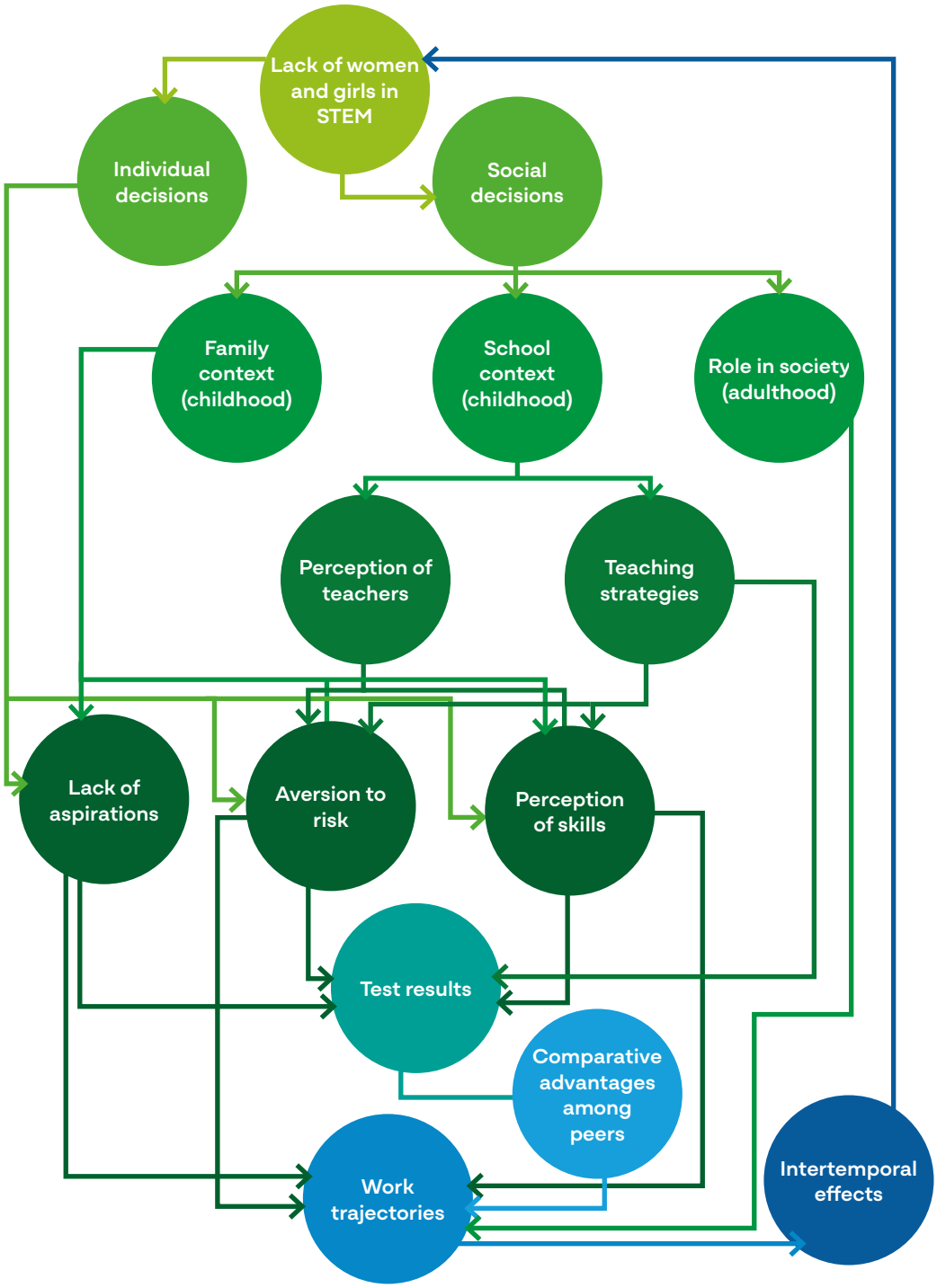


Fig. 1.1: Diagnosis on the lack of women in STEM.

Individual decisions

The set of **individual decisions** includes the choices that people make (both as children and as adults) based on their preferences, but which are also influenced by regulations, culture and prevailing roles.

Aspirations

Girls tend to have less aspirations in the labor market than boys. There is no biological basis for this conduct.

Self-perception of skills

In middle school, the self-perception of skills and performance is better in males than in females (INEEd, 2015, quoted by ANEP, 2019.)

These perceptions on the different skills of girls and boys can be substantiated in teacher surveys and are later questioned by results from STEM tests (Bebras challenge and computational thinking), where girls have higher achievements than boys.[8]

Aversion to risk

It is often said that girls and women have more aversion to risk than males. Nevertheless, these are acquired conducts and there are no biological grounds for the different aversions to risk in people (*Heldman et al*., 2021.).

Social decisions

In the set of **social decisions**, we can differentiate people in their family and school contexts (during childhood and teenage years) and people in their role in society (as adults.)

Family context

Family context: the decision of the family context influences the intertemporal trajectory during childhood, in particular of girls, as well as attitudes to risk-taking and expectations in work development.

Household characteristics (UNESCO, 2019a): assets and supports, family characteristics.

School context

School context (*institutional*): the perceptions of the teaching staff not only have an impact on decisions and choices in careers, but also on the perception of the capacities of boys and girls.

Peer influences (theory of competitive advantages) which partly explain the high dropout rates among boys in the school system and explain the better results obtained by girls in school performance tests despite the perceptions of the teaching staff are also included.

[8] These results are coherent with the theory of competitive advantages described in the table.

Theory of competitive advantages

If one considers a model for optimum decision-making in occupation choices under restrictions, eliminating the barrier limiting the participation of women in some specializations (such as in STEM fields) would increase the opportunities for the youth.

According to Card and Payne (2022), a study conducted for high school students in Ontario, Canada showed that, on average, women achieve the same results as men in mathematics and sciences, yet get better grades in English or French (language) and in other courses qualifying for a choice in specialty and the ranking for school applications

This competitive advantage explains a substantial aspect of the gender differences in the possibility of choosing a STEM specialty, provided STEM opportunities are available in high school. According to the authors, males who attend college are males with good results in STEM. Conversely, women are fit for careers in STEM and for other careers. Hence, among students, women dominate in non-STEM careers and men survive in STEM fields.

Competitive advantages:

Card and Payne (2021) found that women who graduate college are less likely than men to specialize in sciences, technology, engineering or mathematics (STEM.) To analyze the dynamic process leading to this gap, the authors used detailed administrative data for a recent cohort of high school students in Ontario, Canada, combined with data from the college admissions system from the province. They showed that enrollment in STEM programs is mediated by a STEM preparation index based on mathematics and science courses completed by the end of high school. Most of the gender gap in the admission to STEM courses may be attributed to the differences in the rate of preparation for STEM: less than one fifth of the gap is due to differences in major choice subject to preparation. The authors then use data from high school courses to break down the gap in the preparation for STEM among those admitted to college in two channels: one reflecting the gender gap in the group of high school students who meet the prior necessary requirements to study STEM and a second one arising from the differences in the groups of men and women entering college. The gender gap in the group of students who meet prior requirements for STEM is small. The main factor here is the low enrollment rate for men in college, a difference owed to the small fraction of men outside the science pathway who complete enough AP level courses to quality for college. The authors conclude that the differences in course selection patterns and STEM preferences subject to preparation contribute to differences between men and women in rate of enrollment to STEM courses, but that the main cause for this gap is the low general rate of college attendance by men.

Biases in primary and middle school

Data from the United Kingdom show that since early childhood, boys and girls receive different messages about STEM. Although girls start their education path with similar levels of interests in STEM-related activities than boys, families stimulate boys to participate in STEM activities more than they do girls (Heldman et al., 2021)

Stereotypes in the teaching staff

Data from the computational thinking survey from Ceibal prove that the teaching staff perceive boys have a better performance in mathematics and computational thinking than girls.

Teaching strategies, procedures and assessment tools (UNESCO, 2019a)

Test results

The perceptions on performance by the teaching staff **are not backed up by the empirical evidence of Ceibal**, which shows that the performance of girls in computational thinking tests and the Bebras challenge is better than that of boys.[9]

In the United Kingdom, as from high school, the **interest** in the STEM area is higher in boys than in girls. Even when obtaining similar results in standardized tests, the ratio of girls who choose the STEM pathway in high school significantly decreases (*Heldman* et al., 2021).

Adults in society

To a large extent, women have a smaller participation in the labor market due to an **unequal distribution in unpaid tasks**. This unequal distribution of labor makes women have to opt for flexible or part-time jobs to balance taking care of dependents and having a paid job.

The smaller participation of women in the paid labor market creates gender gaps **today** and for the future since interruptions in their work life (due to caring for a dependent, for example) keep women away from decision-making positions and put them on a slower track to advance in the workplace, which then translates to **retirement, pension and wealth gaps**.

On the other hand, women in science and technology earn less than men with the same qualifications (UNESCO, 2016; IDB, 2022).

Among the most common arguments to explain the underrepresentation of women in some fields is the path dependence and the lack of role models in the field (Sierminksa and Oaxaca, 2021.)

There are also institutional and financial barriers.

[9] Other measurements find different results. For example: a study from ANEP (2019) found that in the last year of primary education, the performance in mathematics is better in boys than in girls.

Biases in work life

When it comes to decision-making positions, men in STEM fields are more likely to be promoted to leadership positions than women, even in fields with approximately the same number of men and women. Only one out of ten people in decision-making positions in STEM are women (10.2%) and even less (9%) when it comes to ownership of STEM companies (Heldman et al., 2021). It is also less likely for women **to be promoted** to authority and decision-making positions (UNESCO, 2016.)

- **Men dominate the power structure in science**, which does not equally value knowledge produced by women in the same way (UN Women, 2020.)
- In addition to the low participation of women in STEM fields, there is the fact that men are more likely to work in the private sector in research and experimental development fields (UNESCO, 2016.)

Description of the Uruguayan case

Uruguay has been a global pioneer in guaranteeing the human, sexual and reproductive rights of women.

- In 1913, Law No. 4,802 established the divorce solely by the will of women; Article 5 of the 1918 Constitution separated Church from State. Additionally, Law No. 18,426 dated December 1, 2008, for the Defense of the Right to Sexual and Reproductive Health guarantees the necessary conditions for all the population to exercise their sexual and reproductive rights.[10]
- Women can vote since July 3, 1927.[11] [12]
- Women have access to high school and university education since 1912.[13] [14]
- In line with the global trend, Uruguayan women have, on average, one more year of education than men (considering the adult population aged 25 to 64 years old). It could be argued that what matters are not the years themselves, but the milestones achieved (completing primary school, high school and university). Women also have more college education than men. And the difference there is even bigger: 18% of women have college degrees, while only 12% of men do. This argument goes in favor of the theory of comparative advantages by Card and Payne (2022.)
- At the global level, one out of three women study STEM careers (UNESCO, 2015); among them, an even smaller percentage of women, that is 19%, choose

[10] Access to resources (standards, culture, roles and values.)

[11] https://www.corteelectoral.gub.uy/institucional/creacion_y_evolucion

[12] Decisions and power (voice and agency.)

[13] https://www.rau.edu.uy/uruguay/cultura/Uy.educacion.htm

[14] Resource control (financial autonomy, education, knowledge, work.)

[15] https://genlac.econo.unlp.edu.ar/home-en/

computer engineering or technology. Something similar happens in Uruguay. Although 63% of people who enrolled in Universidad de la República in 2018 (as per the last available data) were women, only 23% of those enrolled in the School of Engineering were women. Most women are take courses related to social and human sciences or health.[18]

- Additionally, and on average, Uruguayan women participate in the labor market more than other women in Latin America. This is partly due to a higher human capital of women. Two thirds of women participate in the labor market in Uruguay, a much higher figure than the world average (50%) and higher than the figure for most countries in Latin America. Nevertheless, there is horizontal work segregation (women participate less in STEM fields), as well as vertical segregation (women participate to a lesser extent than men in decision-making processes.) This vertical segregation is also observed in the university sector and in the national researcher's system, in which women occupy lower ranking positions (ANEP, 2019.)

Uruguayan policies geared towards gender equality in science, technology and innovation are expressed through specific, disaggregated actions which sometimes have different criteria for the same topic. Furthermore, in many cases, those policies are based on personal actions and are not formally included in institutions (OPP, 2017.)

[16] https://genlac.econo.unlp.edu.ar/home-en/

[17] https://www.stemwomen.com/blog/2021/01/women-in-stem-percentages-of-women-in-stem-statistics

[18] Source: https://www.anii.org.uy/upcms/files/listado-documentos/documentos/informe-pa-s-vf.pdf

Data and indicators for decision-making

This chapter describes data used in this work, the roles of indicators, the role of statistics with a gender approach and their relation to the conceptual framework when measuring gender equality in the STEM ecosystem of Ceibal.

Data

Data have a veneer of objectivity but are not objective in and of themselves. Each data stems from a measurement based on a specific theoretical framework and a worldview. Data create stories, and those stories help us see where we are heading and how to stay on course or correct it.

The roles of data, through the indicators we use, are:

- **descriptive**
  getting a snapshot of reality at a given time
- **predictive**
  building a story of what may happen based on that snapshot
- **propositional**
  giving advice on which story out of all stories possible we want to have happen

For example, when building the GDP of each country "the final goods and services produced in a specific economy at a given time" are added up.

The GDP is a construct that seeks to homogenize, standardize and compare economic growth rates between countries (or in a country through time.) Although it may seem like an objective, harmless measurement, as Ha-Joon Chang says: There is a perspective on the world behind every data collected.

This example of GDP shows that: if someone lives in their own home, an imputed income (corresponding to the service of living in a home paid by the person who rents the home to the owner) is included to calculate the GDP. Nevertheless, if someone cleans their own home, that service is not included in the GDP. Now, if someone cleans someone else's house, it is, because the person receives an income for cleaning that house which does not belong to them.

Why is cleaning your own house not included in the GDP and living in your own home is? There are no theoretical grounds for that. It is

a convention, probably created by homeowners who did not clean their houses. Here is where we see once again that including more visions or perspectives in the construction of the GDP would have been beneficial. Indeed, the country would be richer (the GDP would be higher) if payment for that work were included in the GDP.

In the same way that the GDP data is useful when monitoring a situation, data allows us to transform information into knowledge and use that knowledge to go deeper into what is right and correct what is not.

About our data:
How much should we trust data?

1. Who produces data?
Data used in this dashboard are produced by Ceibal. Each unit responsible for the STEM programs, resources or devices provides the Office of the Manager for Data and Behavioral Sciences a sheet with information used to produce the indicators selected here.

2. Which are the sources for data?
Data used to build indicators are generated in Ceibal. They are available on a website to promote their use by the population (to conduct statistical analyses.) They are as disaggregated as possible, thus allowing to preserve the privacy and confidentiality of people to whom that data refers.

3. Does data describe the phenomenon as a whole or does it represent a random sample?
Data describe the phenomenon as a whole. Data do not come from a sample.

4. Data processing

Missing data have been eliminated. Duplicated data have been eliminated.

5. Have mathematical or scientific models been used in data processing and analysis?
Data are presented as collected. People are counted. Then, the gap between men and women is calculated. If there is gender equality, the gap is zero.

Indicators

An indicator is a summary measure informing decision makers on the current status of the target to be measured.

To show progress in a policy, the literature suggests choosing indicators **directly directed** with the purpose of that policy. The purpose of this work is to **calculate the gender gap in Ceibal's STEM ecosystem**.

For indicators to be accepted by all people involved, it is convenient to choose indicators in the context of a **participatory process** (UN, 2020.) Consequently, and by initiative of Ceibal's **Office of the Manager for Data and Behavioral Sciences**, a collaborative process has been initiated with all STEM fields of the institution to unify concepts and systematize already available information. Monthly meetings were held with all fields involved where knowledge on the objective of this work, as well as on the significance of the quality of information collection has been transferred, since, in short, conclusions shall depend on the good quality of data. A work schedule for the collection and analysis of information has been established so that data may be periodically updated.

Given the aforementioned reasons, it is desirable to develop indicators **by and for** policies to guarantee a coherence with results, strategies and actions expected, as well as with the sociocultural context in which those policies are implemented.[1]

Gender indicators

Gender indicators reflect the situation of people in a summarized, comparative way.

Normally, the literature on gender statistics combines two aspects: **the quality of statistics** in which gender is included as an explanatory variable in social, demographic and financial statistics.[2] The second aspect refers to a specific, finite set of statistics related to the **access to opportunities, resource control and decision-making**, which reflects on the situation of **equality, parity or equality** between males and females throughout their life cycle.

Ceibal covers both types of gender indicators. The first dimension is included in Ceibal's Data Observatory. The second dimension is included in the **dashboard of gender indicators in the STEM ecosystem** presented in this document.

[1] There are multiple classifications for indicators since they are used for different things. Two of the most widely used typologies are those that classify indicators into two categories: according to result levels (process, effect and impact) and according to the type of information manage and generated (quantitative, qualitative and mixed.)

[2] These types of indicators reflect changes in a group with respect to another in certain matters of interest, such as the education, work, health or location situation.

Statistics with a gender approach

The literature on gender statistics identifies the need for a gender approach in five fields:

- **Content: which topics matter**
  - By collecting data on matters of gender and activities, interests and concerns of women, the quality of statistics improves, as specific situations, problems and needs are made visible. According to the United Nations (2013), women and groups of women must actively participate in decision-making processes that identify priorities in data and determine which data will be collected.
- **Structure**
  - We recommend reviewing concepts, definitions and classification systems with a gender equality approach.
- **Data-collection methods**
  - Data-collection methods must be reviewed and adapted considering stereotypes and social and cultural factors that might create gender biases. In particular, the implementation of specific measures to deal with the underreporting of the financial activity of women, the violence against women and, in some cultures, the underreporting of births and deaths in girls must be considered.
- **Data compilation and dissemination**
  - Data should be primarily disaggregated by biological sex (administrative data) and then by classification (for example, job by sex, age, geographical region.)
- **Data analysis**
  - When analyzing data, the gender approach should be included. For example, when interpreting the access to electricity in households, once must include its impact on house chores (access to appliances that simplify it: stoves, washing machines, dishwashers.)

Sources: UNECE (2013), UN (2020.)

Gender indicators in Ceibal's STEM ecosystem

The gender indicator chosen is the gender gap, a conceptually clear, easy to interpret indicator with an internationally accepted definition. Additionally, it is

possible to periodically produce this indicator with a wide scope, allowing for an analysis of its evolution as time goes by (UN, 2020).

For example, the number of girls in STEM in a school is a piece of statistical data but not an indicator, since it does not allow for a comparison between schools. The meaning of this data depends on the number of students: 100 girls doing STEM in a school with 200 students has a different connotation than 100 girls doing STEM in a school with 300 students. Conversely, the gender gap which is calculated as

$$\frac{\text{(boys doing STEM + girls doing STEM)}}{\text{(boys doing STEM + girls doing STEM)}} \times 100,$$

is an indicator that allows for making comparisons between schools. The gap is 0 in the first case and 33% in the second school.

An indicator is a statistical data standardized or with a benchmark allowing for comparisons between populations.

Gender gap
The gap is calculated as the quotient of the difference between the interest population and the total. For example: the gender gap is calculated as (men – women) / (men + women.) The gender gap is an indicator. Often, it is multiplied by 100 to express it as a percentage.

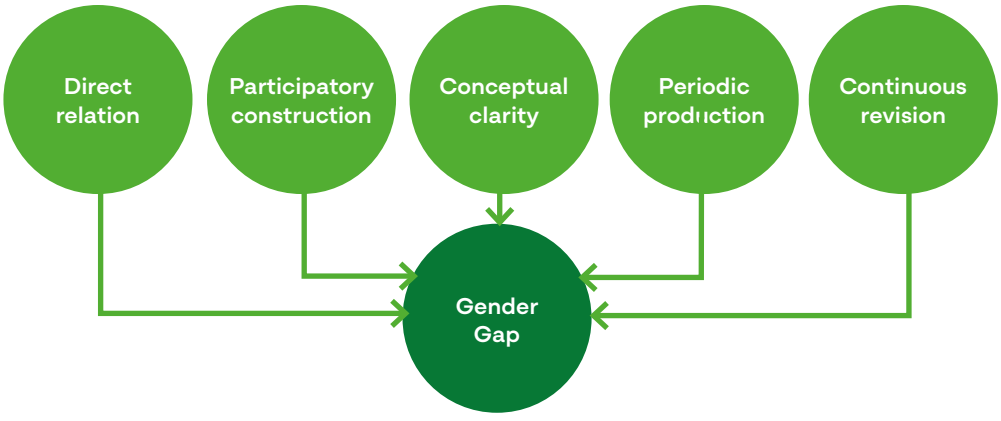


Fig. 1.2: Characteristics of gender indicators in the STEM ecosystem of Ceibal.

Functions of the dashboard of gender indicators

The dashboard of indicators plays three roles:

- **highlighting the situation of girls and women in STEM fields** (students and teachers);
- **producing statistical evidence** in a standardized way to predict what may happen if the same course of action is maintained and make inferences about the causes for this situation;
- **making proposals** to maintain the situation or correct it if necessary.

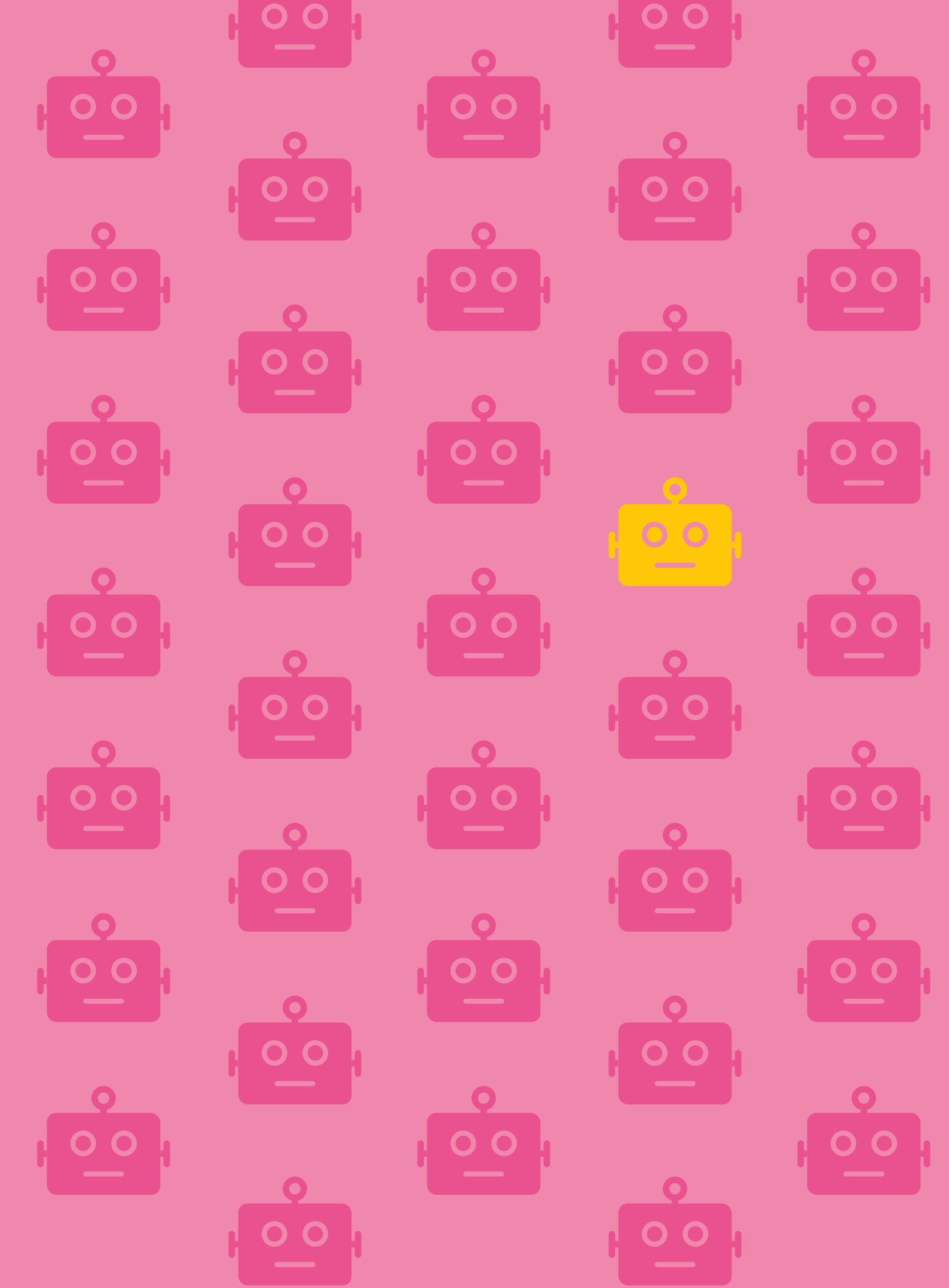
The dashboard of indicators measures **direct and indirect effects** of Ceibal's STEM ecosystem in the access of people to opportunities, in the control of resources and in the participation in responsibility and decision-making positions.

There are **direct** effects when the actions of a given program or policy are specifically focused on increasing both the number and importance of women (for example, a STEM activity specifically targeting girls.)

There are indirect effects when the actions of a program or specific policy are not geared to increasing the ratio of women or their role in the direction yet still have consequences on the matter. For example: an initiative incentivizing the technological development in companies. Even if the target group are tech companies, these companies are made up of men and women, both as owners and as workers in different positions and generally under unequal situations given the horizontal and vertical gap segregation. Hence, this initiative can help strengthen, maintain or reduce these inequalities.

Why a dashboard and not an aggregated index?
We chose to show information in a dashboard of indicators and not as an aggregated index because:

- When adding up the set of indicators to build an index, we are implicitly assuming that **their components can be perfectly substituted**. For example: if a composite index includes indicators from two STEM programs (for example, Computational Thinking and Jóvenes a Programar), it is assumed that a gap favorable to men can be compensated in an indicator with a gap favorable to women in the other.
- When aggregating in a linear way, it should be assumed **weights or weightings** for each indicator making up that aggregated index. In that case, it is also necessary to have a theoretical model justifying the situation. Using a uniform function (assigning the same weight to all indicators) is a measure of our ignorance, not of their true weight.



Part 2

- Methodology
- Mapping the STEM ecosystem in Ceibal
- Digital tools
- *Jóvenes a programar*
- Computational thinking
- Robotics, Programming and Videogames Olympics
- Short programs
- Digital citizenship
- Scientist in the classroom

Methodology

This section of the document presents the methodology used in the analysis.

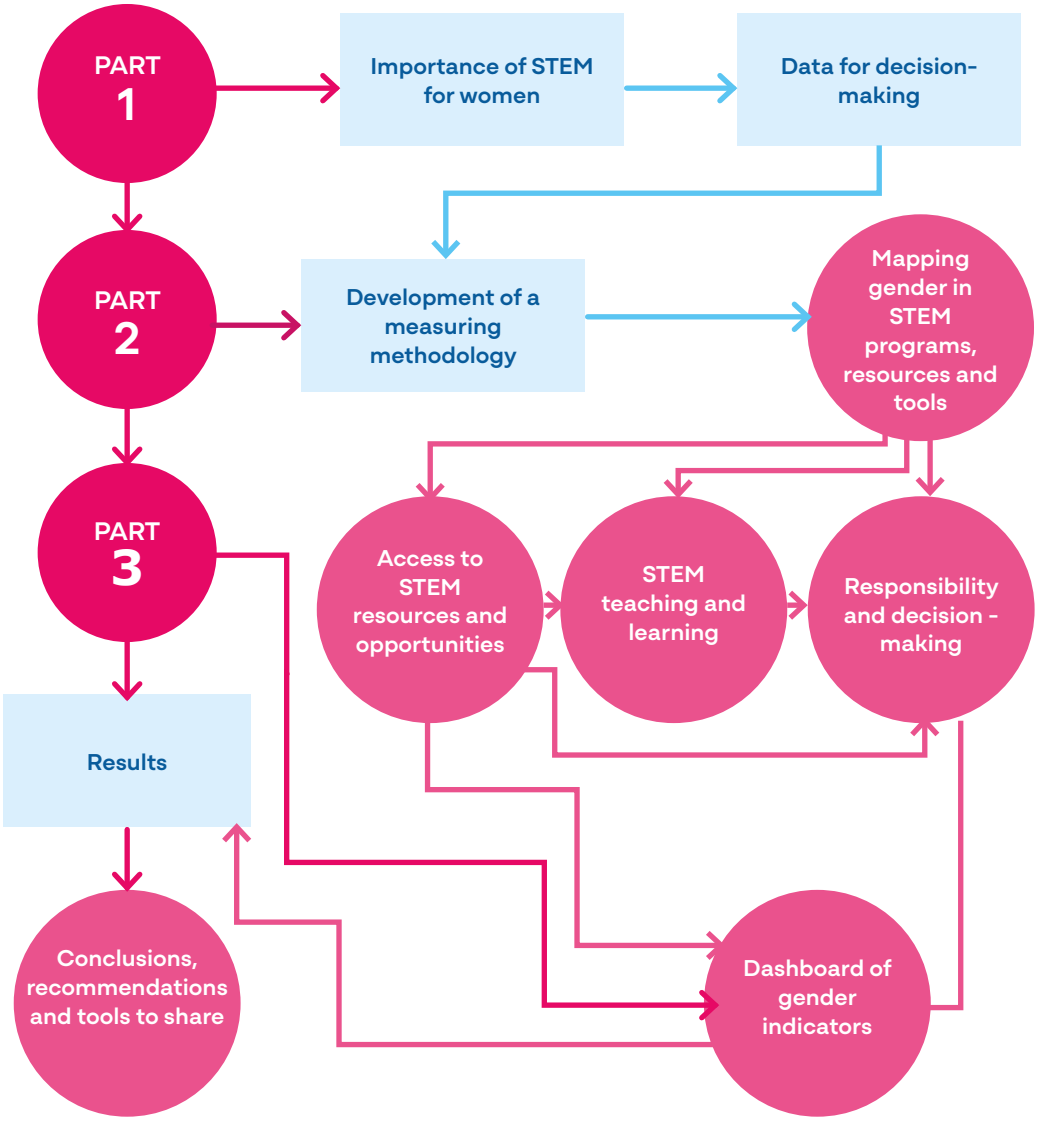


Fig. 2.1: Analysis structure, part II.

This chapter presents the systematization structure for STEM quantitative evidence which Ceibal has been conducting since its inception in 2007.

To build the dashboard of gender indicators, a conceptual framework was developed to systematize quantitative and qualitative evidence. This conceptual framework is shared to foster constructive exchanges and create empirical evidence to facilitate decision-making processes.

The most important question this work poses is whether the **STEM ecosystem reduces, maintains or increases gender inequalities between men and women.**

Information for each program, digital tool or device in Ceibal's STEM ecosystem was systematized with a section structured as follows:

(i) Detail of the program's **objectives** and their relevance for gender equality, focusing on whether they have an impact on the r**egulations, roles, values and stereotypes** (access to STEM resources and opportunities), on the control of those resources (**teaching/ learning** deriving in later financial autonomy) or on **decision-making and power** (if it affects the possibility of having a voice in responsibility positions.)

(ii) For each of these fields, gender **indicators were designed and measured**.

(iii) In as much as possible, **effects are analyzed and conclusions and recommendations to be shared** (lessons learned) **are reached**.

Conceptual framework

The conceptual framework adapted to assess the effects by gender of Ceibal's STEM ecosystem uses the analysis model developed by the European Institute for Gender Equality (EIGE). It has been adapted and modified for the Ceibal case since most of the population analyzed is of school age (primary and middle school.)

From the beginning, the structure proposed by the EIGE (2017) poses that the promotion of gender equality in public policies is relatively recent, and that with each implementation the knowledge baggage expands, thus modifying the analysis structure. From a historic perspective, the gender equality analysis is relatively recent. For example: in Uruguay, the law on equal compensations by gender was enacted in December 2019.[2]

[1] At the European level, there are still no regulations, models or common developments in the public administration (EIGE, 2017.)

[2] https://www.impo.com.uy/bases/leyes/19846-2019

Each analysis concept or dimension defined and used in this research on Ceibal's STEM ecosystem to systematize information is embedded in a structure of other concepts which comprise a hierarchy and also contribute to the creation of new concepts (Skemp, 1987.) The classification of indicators used in this work is non-exclusive, and an indicator can belong to more than one category.[3] Following the initial guidelines by EIGE (2017), we have drafted the conceptual framework for the STEM gender analysis in Ceibal (Fig. 2.2.)

People in society: Ceibal's conceptual framework

The conceptual framework considers people as social beings and identifies a series of observable characteristics that may have an impact on the access to STEM resources and opportunities in the early stages of life. This dimension includes characteristics of:

- use of time, in particular the division of paid and unpaid work;
- age;
- ethnicity;
- opportunity to access education (infants) and education level of adults in the household;
- social class;
- living arrangements;
- relationships between adults, between adults and infants, maternity, paternity;
- opportunity to participate in society;
- influence of the press.

The dimension of teaching/learning of STEM resources providing financial autonomy includes learning by people, as well as horizontal segregation in the labor market.

The decision-making and power dimension includes the characteristics allowing for the participation of people with a voice in decision-making positions, as well as those that guarantee the opportunity to participate in society, including wielding power in boards of directors, companies or organizations with political participation.

[3] For example, an orange can be classified as: (i) a fruit (just like pears and apples); (ii) a source of vitamin C (just like broccoli and bell peppers); (iii) a part of exports (just like, in the case of Uruguay, beef and software.

[4] The glossary includes a definition of segregation in the labor market.2 https://www.impo.com.uy/bases/leyes/19846-2019

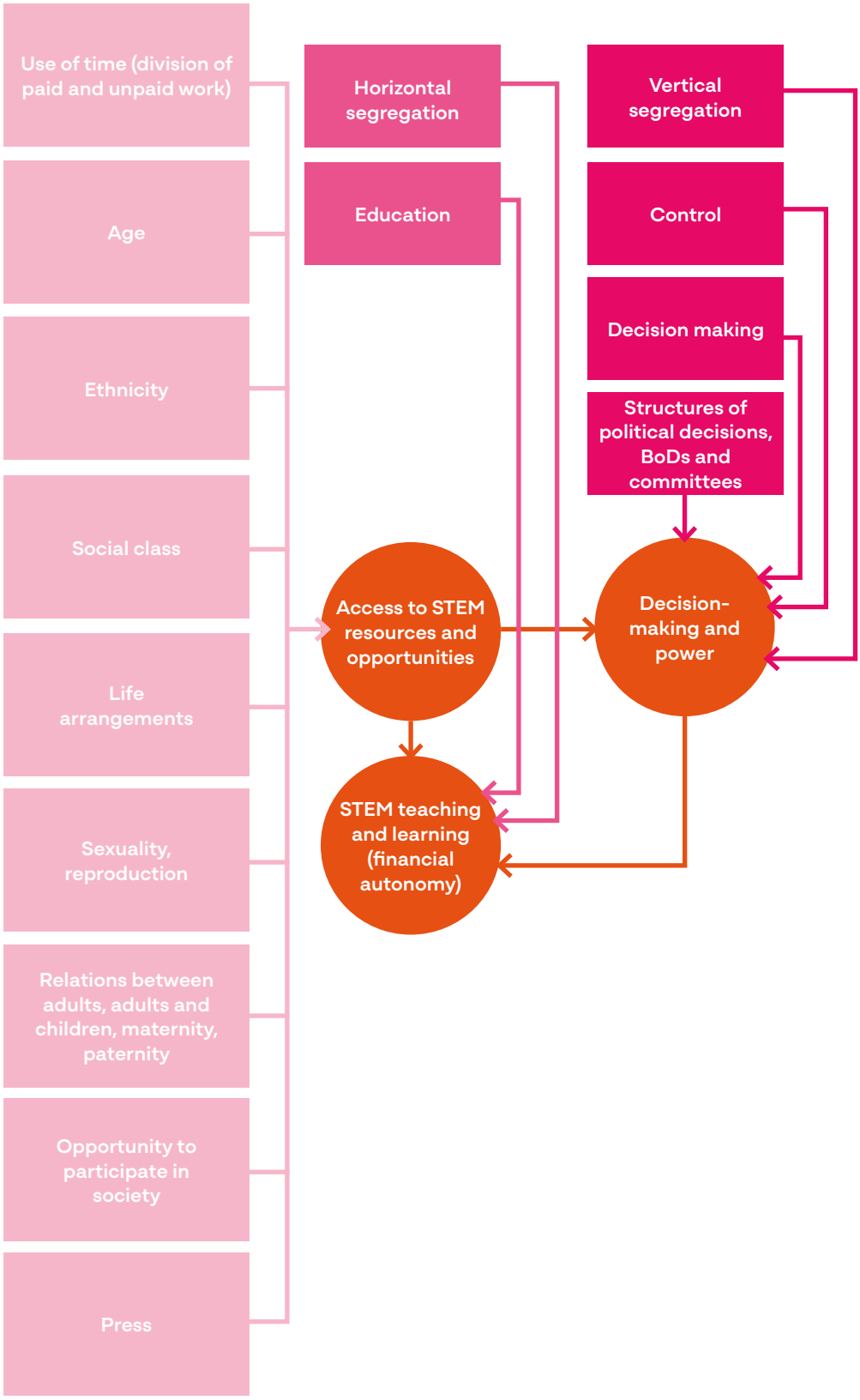


Fig. 2.2: People in society, conceptual framework by Ceibal

Similarities and differences between EIGE and Ceibal

The main similarity is the analysis dimensions identified as relevant. Starting from the EIGE methodology (2017), this work has identified that the **access to and control of resources**, as well as the **financial autonomy** and **participation with a voice in decision-making positions** are important dimensions of the gender analysis.

The main difference lies in that **Ceibal** identifies a **sequential** logic in which regulations, roles, values, and stereotypes have an impact on the **access to resources and opportunities** on the part of girls and women, and this has intertemporal consequences on the **control of resources** and the financial autonomy of women. Additionally, these two dimensions (access to resources and opportunities and financial economy) later have an impact on **decision-making and power.** The comparison between methodologies is shown in figure 2.3.

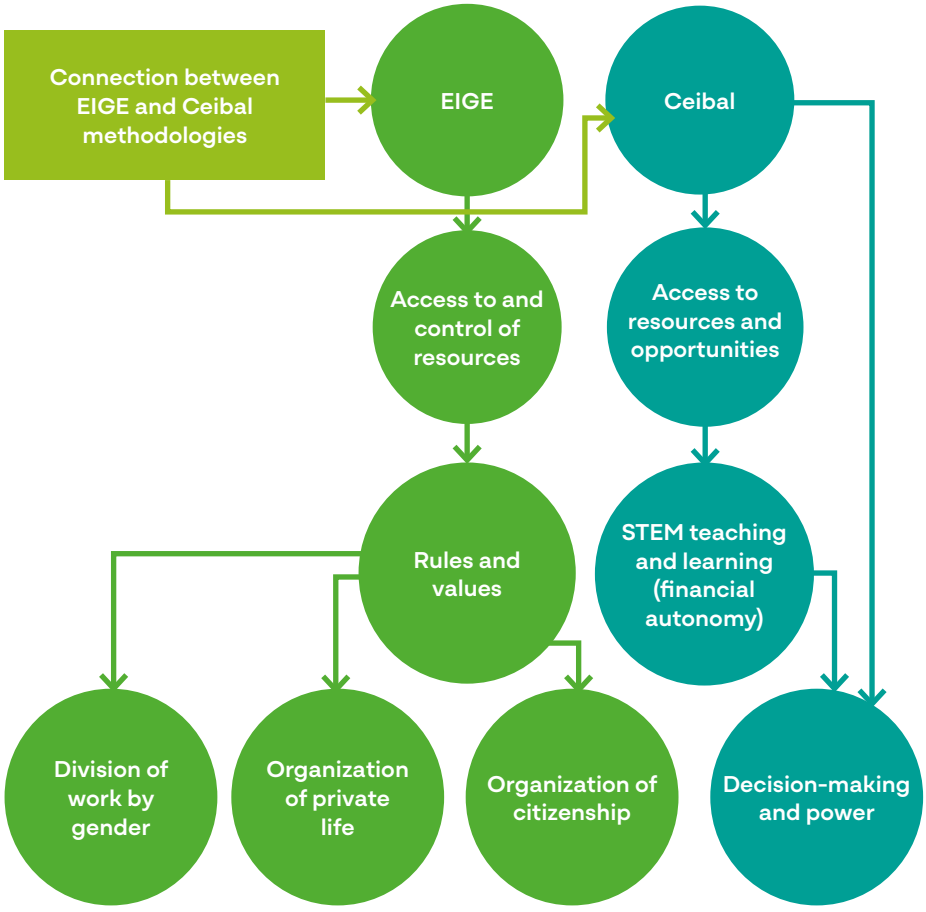


Fig. 2.3: Comparison of EIGE and Ceibal structures.

Evidence-systematization structure

This work has identified the following dimensions:

- **Access to STEM resources and opportunities**, including regulations, culture, roles, values and stereotypes associated to each gender. This also includes the use of time.

Regulations, values, roles and stereotypes have a later impact on horizontal segregation in the labor market, aspect included in the **STEM teaching / learning dimension.**

- Culture, roles and values are regulated by a set of rules and stereotypes in the fields of coexistence, sexuality and reproduction, relationships between men and women and between adults and children. There are different roles expected of men and women, different assessments (maternity/paternity) which have a subsequent impact on social life. Gender inequalities can be reinforced by specific criteria of cultural, ethnic or religious diversity or to diversity related to age (EIGE, 2017.

- **STEM teaching/learning.** Resource control that enables financial autonomy. This includes activities focused on boosting the skills of women (education and training) and their access to resources (knowledge, work, money.) This dimension also includes activities related to access to health, wellbeing, mobility and safety.

The structures that organize the division of work regulate the distribution of work based on the prevailing rules and values in the workplace. This relates to the distribution of paid and unpaid work and the horizontal gender segregation in the labor market (EIGE, 2017).

- **Decision-making and power**, which includes measures focused on guaranteeing the exercise of fundamental rights (civil, social, political), giving a voice to women and increasing their participation in decision-making positions, as well as other matters pertaining to the exercise of power.

Ceibal methodology and action plan

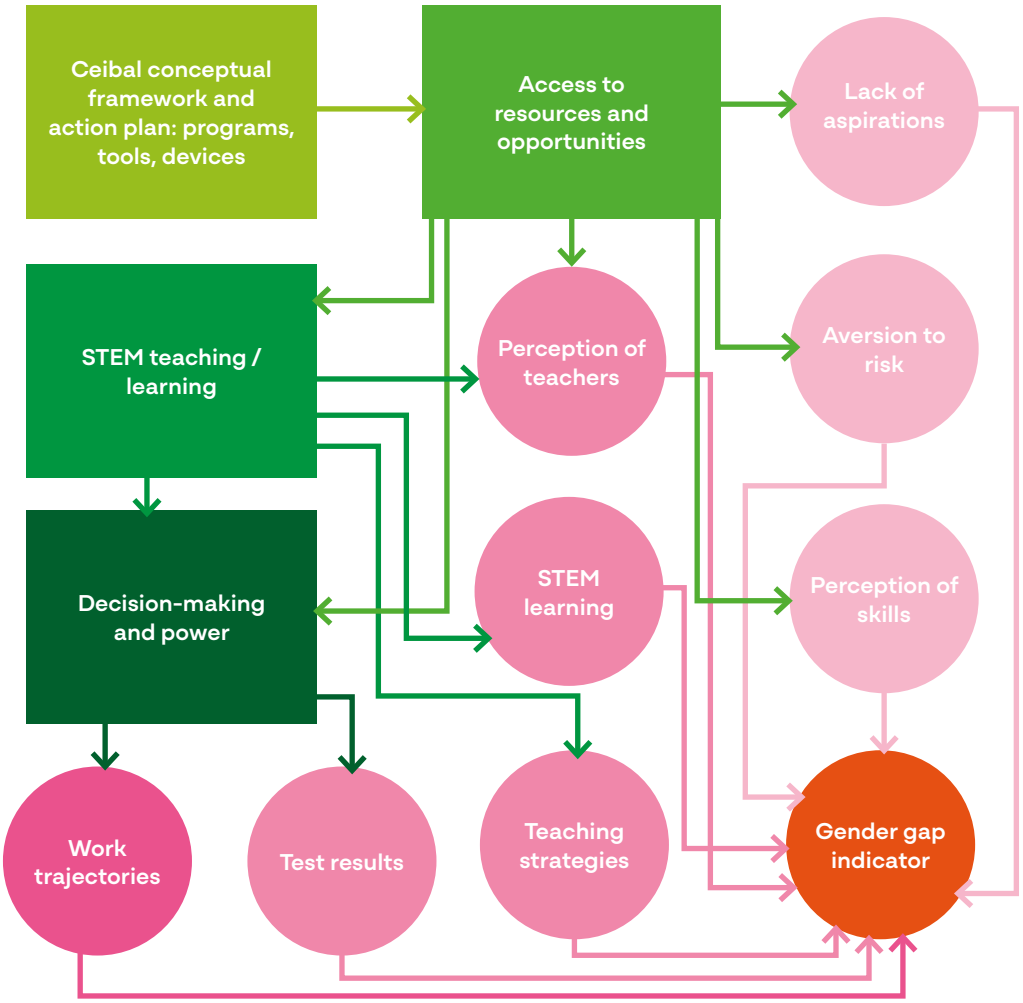


Fig. 2.4: Ceibal: conceptual framework and action plan.

Ceibal's STEM Ecosystem Mapping

This chapters maps Ceibal's STEM Ecosystem.

Since its inception in 2017, Ceibal has provided its target population (teachers, families, students) with a set of **devices, digital tools and programs** to foster equality (in socioeconomic, geographic and gender terms.) This chapter specifically focuses on the gender dimension and the effect of those **devices, tools and programs** on those involved in STEM fields.

Although "gender" is the variable of interest (a self-perception and not dichotomous variable), when using administrative information (for example, the identity card), the variable available to Ceibal is biological sex.[1]

Devices, digital tools (resources), programs

Ceibal is a dynamic institution in constant evolution, and that is reflected in the nodes network (programs, devices, tools) connected to the citizens, families, students and teachers

Unit of analysis: the person

This work maps all devices, digital tools and STEM programs in Ceibal's ecosystem and presents gender gap information for those (devices, digital tools and programs) in which the unit of analysis is the beneficiary (students or teachers).

[1] As more information on gender is recorded, the information on biological sex shall be replaced

Fig. 2.5: Ceibal's STEM Ecosystem.

Devices

Ceibal delivers devices to people (ceibalitas or tablets, laptops and micro:bit boards) and to schools (drones, robotics kits, physico-chemical sensors, 3D printers).

Name	Opportunities and resources	Teaching learning	Decisions and power	Target population	Since	Indicator: gendergap
Ceibalita	x	x		Students	2007	Delivery
Micro:bit board	x	x		Students	2018	Delivery
Micro:bit board	x	x		Teachers	2018	Delivery
Robotics kits	x	x		Education center		
Drones	x	x		Education center		
3D printers	x	x		Education center		
Physico chemical sensors	x	x		Education center		

Personal devices

Ceibalita (Primary Education)

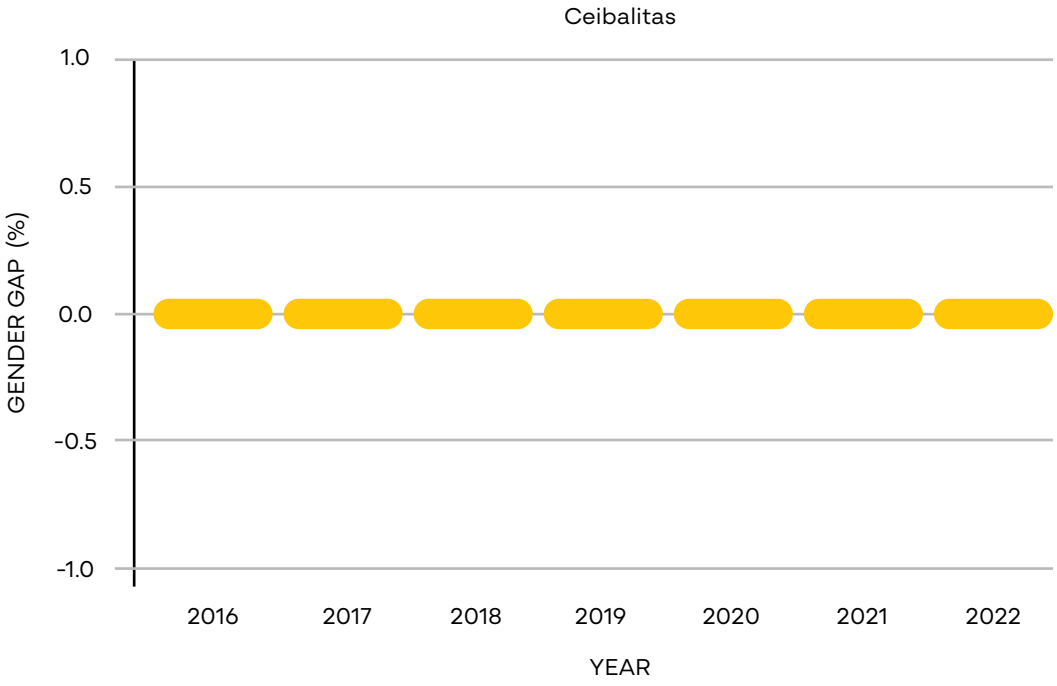
The **most well-known device** is the ceibalita, a personal laptop computer, which has been given to every beneficiary (teachers and students) of primary education since 2007 and changed for a new one every year. For some time now, the program also includes secondary education students and teachers.

The graph shows the gender gap by ceibalita in the public primary education system.

Although the graph shows information since 2016, information has been available since 2007, and no gender gap has been observed in those years.

Since 2007, ceibalitas are being delivered to each student in Uruguayan public education. There is no gender gap.[2]

[2] The use of ceibalitas can be measured by the condition of "the circulating units" by August of each year. One might assume that girls are more careful with the devices and that there might be a gender gap favorable to women in this case.



Micro:bit boards

Since 2018, in addition to ceibalitas, micro:bit boards (programmable boards) are handed out. The characteristics of delivery, monitoring and use of this device are different from those of the ceibalita.

These boards are not universally distributed but rather delivered upon request. The teachers or students who request them have to explain what use they intend to give the boards.

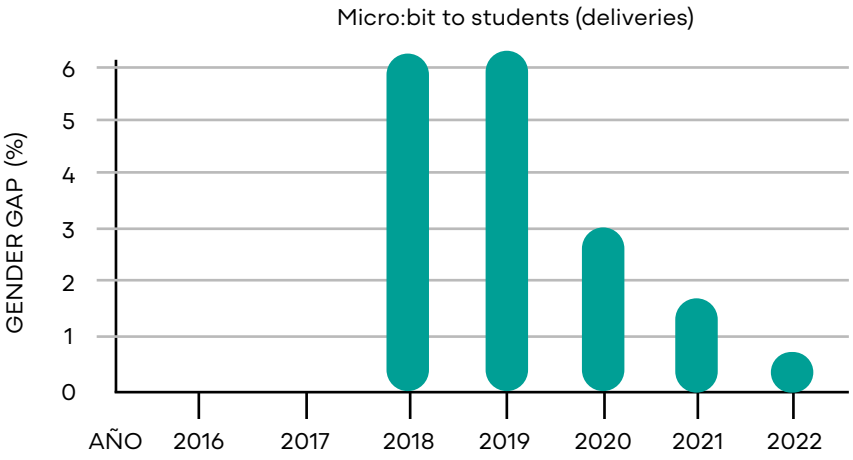
The micro:bit intends to be a low-cost tool that allows teachers and students across the country to delve deep into basic matters of programming and computational thinking individually or in groups.

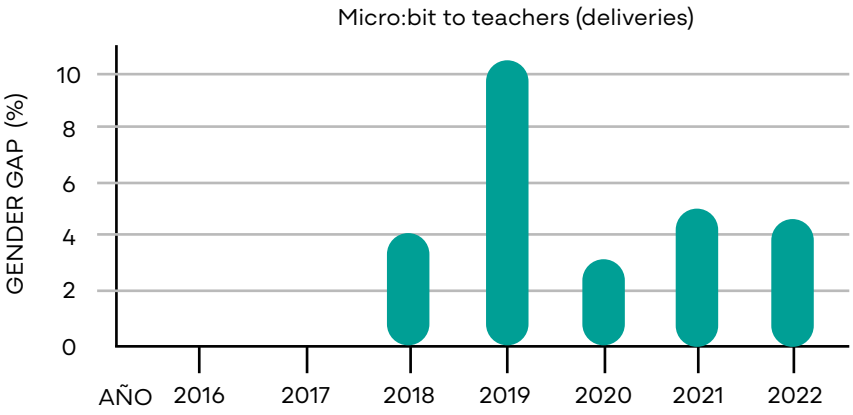
The target population is the group of students from 5th form in primary to 3rd year in middle school, as well as their teachers.

Since July 2018, over 90,000 micro:bits boards have been delivered between teachers and students.

Link: https://microbit.ceibal.edu.uy/

For micro:bit boards, the gender indicator chosen is "delivery". The indicator is available since 2018; there is a gender gap favorable to men.





Devices by school

Additionally, there is a series of devices delivered to the school: robotics kits, physico-chemical sensors, drones and 3D printers.

Digital tools

There are **digital tools** (resources) made available with the aforementioned objective of providing equal opportunities. Among these tools there are portals for teachers and students, websites that gather information on the tools available for each group. Teachers or students, depending on the case, will log in to these portals using a password and access **digital tools** that enable STEM learning and practice. There are also tools for families (Aprender Todos); no personal information is collected.

The aim of the tools is to facilitate the learning of skills (**ensuring financial autonomy** and **breaking down barriers and stereotype**s that limit opportunities for people to acquire specific knowledge.)

Literature shows that this conditioning, if acquired at home and maintained at school, continue through the school life and creates gaps in the labor market.

Ceibal's digital tools are classified in:

- plataforms,
- projects,
- interfaces with educational content.

A mapping of these digital tools is included, as they directly contribute to breaking down gender stereotypes. As progress is made in the development of measuring strategies, the effect or impact of these resources on gender **equality** shall be included.

Name	Category	Dimension	Target	Since	Indicator: gender gap
CREA	Platform	Teaching learning	Students and teachers	2019	Comments mean, delivery mean, visualizations mean
CREA (Computational Thinking)	Platform	Teaching learning	Students and teachers	2019	Comments mean, deliverables mean, visualizations mean in the Computational Thinking program
Mathematics platform PAM	Platform	Teaching learning	Students and teachers	2013	Average number of days of access to platforms by education subsystem, average of activities carried out by education subsystem
Mathematics platform Matific	Platform	Teaching learning	Students and teachers	2019	Average number of days of access to platforms; primary education
Minecraft education	Project	Teaching learning	Students and teachers	2020	

Name	Category	Dimension	Target	Since	Indicator: gender gap
Mathematics training	Project	Teaching learning	Teachers	2018	Enrollment in training courses
Biblioteca País	Interfase	Teaching learning	Students and teachers	2018	Percentage of access coverage, average number of days of access, and average of loans by education subsystem
Videogames	Interfase	Teaching learning	Students and teachers		
Valijas	Interfase	Teaching learning	Students and teachers		

In the case of CREA and Minecraft Education, Ceibal has information available on resources. This high frequency information (varying by connection hours or minutes) is available on the Observatory.

Platforms

CREA

CREA is a virtual learning platform, a collaborative work environment in which students and teachers can communicate and exchange experiences.

In CREA, each teacher can create groups, lecture inside the curriculum, propose tasks and follow-up on the grades of his or her students in a space that fosters knowledge by promoting planning and the collaborative creation of educational resources among colleagues.

This platform, just like a social network, is a virtual learning environment that allows people to manage courses, create and share didactic materials for students and work in groups. The use of CREA complements face-to-face education with virtual education and enables the development of hybrid pedagogical proposals

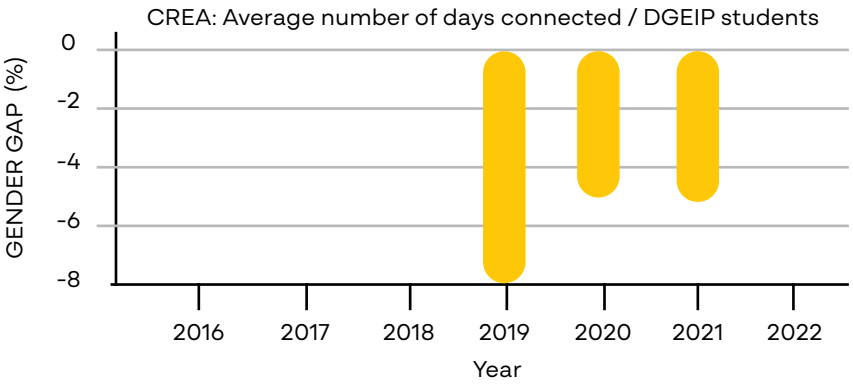
Gender gap indicators for the CREA platform mentioned in this document are:

Gender gap in platform access, by educational subsystem, for students {-}

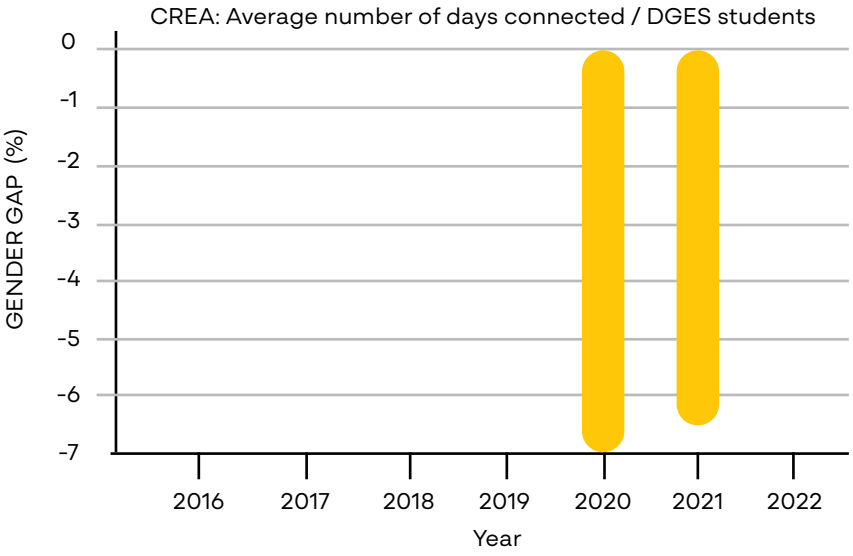
- CREA: Access to DGEIP student platforms
- CREA: Access to DGES student platforms
- CREA: Access to DGETP student platforms

Access gap in average connected days, by educational subsystem, for students and teachers {-}

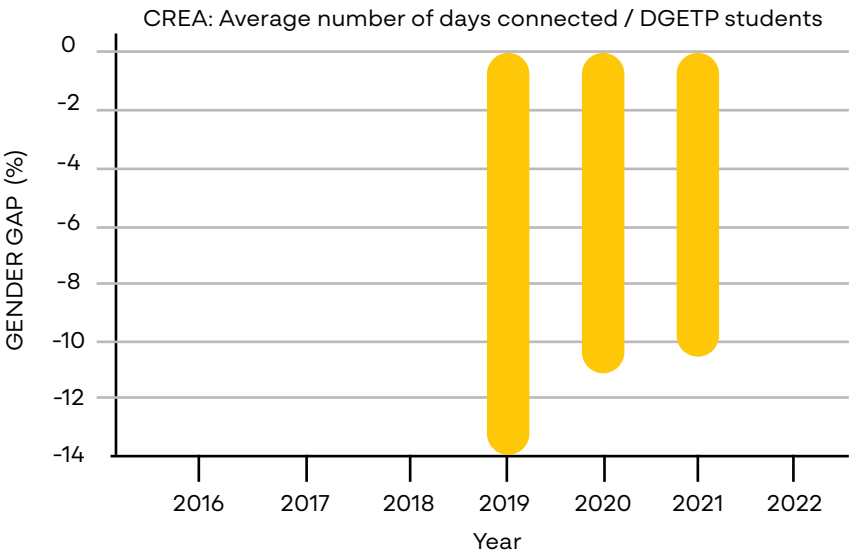
- CREA: Average number of days connected / DGEIP students
- CREA: Average number of days connected / DGES students
- CREA: Average number of days connected / DGETP students



In the case of primary education, the gap is favorable to girls and was 4% in 2020-2021.



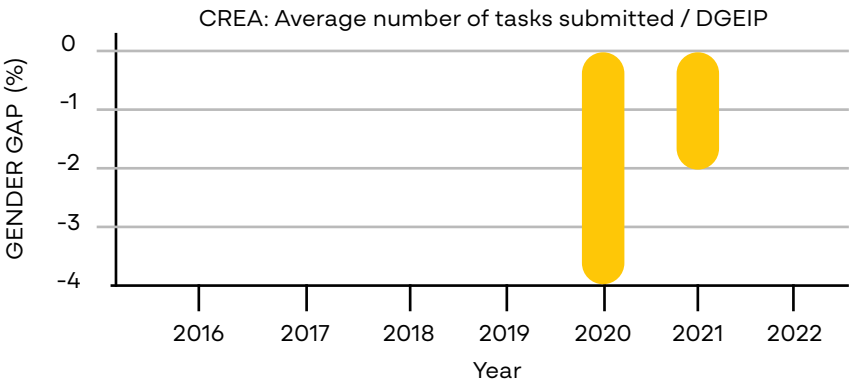
In the case of secondary education, the gap is favorable to girls and was 6% in 2021.



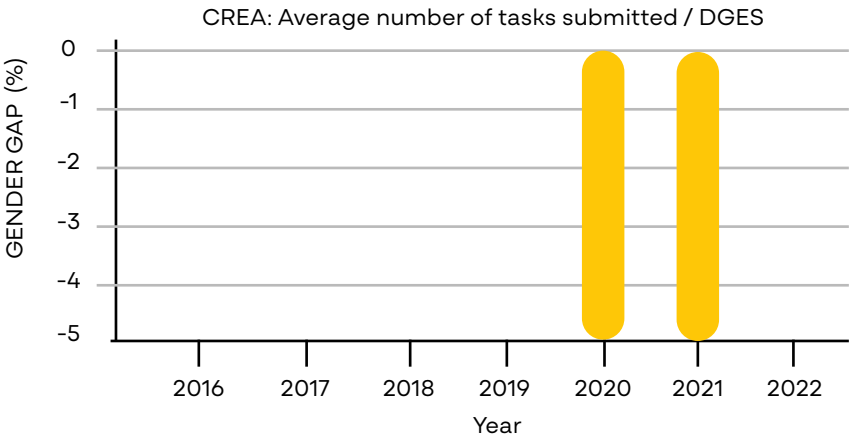
In the case of vocational and technical education, the gap is favorable to girls and was 10% in 2021.

Access gap in average number of tasks submitted, by educational subsystem, for students and teachers {-}

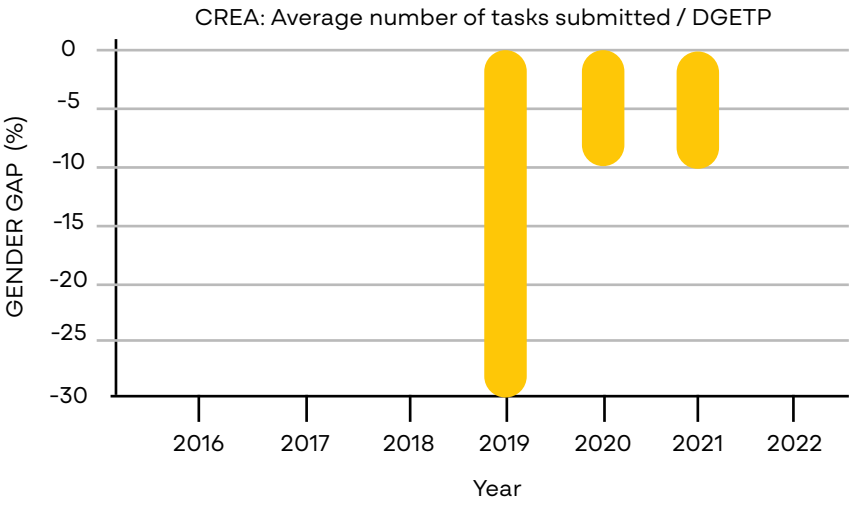
- CREA: Average number of tasks submitted / DGEIP
- CREA: Average number of tasks submitted / DGES
- CREA: Average number of tasks submitted / DGETP



In the case of primary education, the gap is favorable to girls and was 4% in 2020-2021.



In the case of secondary education, the gap is favorable to girls and was 5% in 2020-2021.



In the case of Vocational Technical education, the gap is favorable to girls and was 10% in 2020-2021.

Gender gap in platform access, by educational subsystem, for teachers {-}

- CREA: access percentage / DGEIP teachers
- CREA: access percentage / DGES teachers
- CREA: access percentage / DGETP teachers

Gender gap in the average number of days accessing platforms, by educational subsystem, for teachers {-}

- CREA: Average number of days accessing platforms / DGEIP teachers
- CREA: Average number of days accessing platforms / DGES teachers
- CREA: Average number of days accessing platforms / DGETP teachers

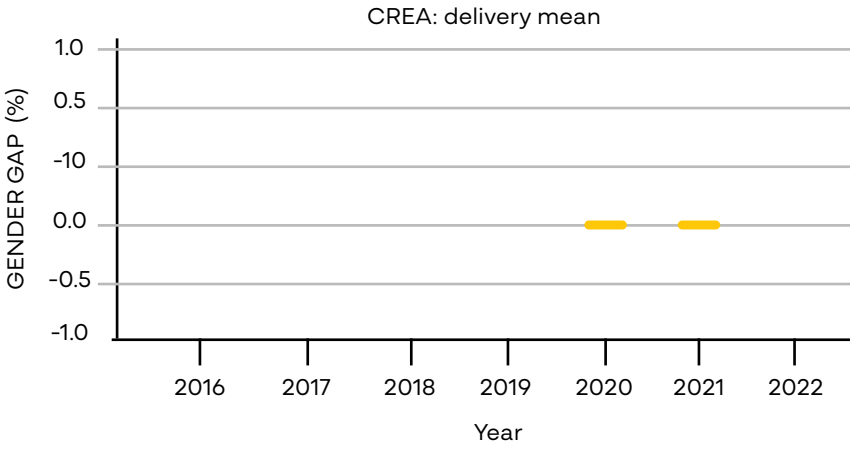
Indicators display is available at https://ceibalunidaddatos.shinyapps.io/genero-STEM/.

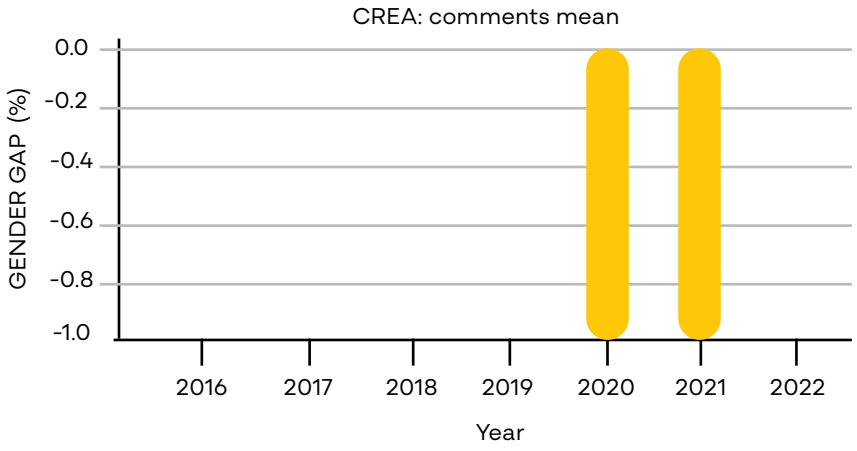
CREA Computational Thinking

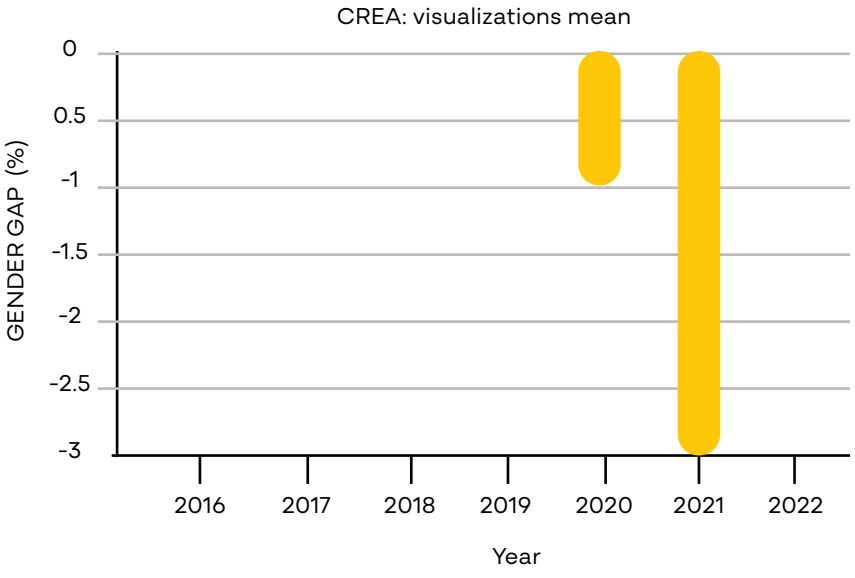
This document includes the gender gap indicator in the access to and use of the Computational Thinking program's CREA platform.

In the case of CREA, in addition to high-frequency information available on the Observatory, this document presents information on the gender gap in the delivery, visualizations and comments mean on the platform for the Computational Thinking program.

Information is available since 2020. No gender gap is observed in the delivery and there are gender gaps favorable to girls in the comments and visualizations mean; these are around 1% and 3%, respectively.


CREA: delivery mean
GENDER GAP (%)
1.0
0.5
-10
0.0
-0.5
-1.0
2016
2017
2018
2019
2020
2021
2022
Year


CREA: comments mean
GENDER GAP (%)
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
2016
2017
2018
2019
2020
2021
2022
Year


CREA: visualizations mean
GENDER GAP (%)
0
0.5
-1
-1.5
-2
-2.5
-3
2016
2017
2018
2019
2020
2021
2022
Year

Mathematics platform

Gender gap indicators for the PAM (in the three educational subsystems) and Matific (for primary education only) platforms are detailed.

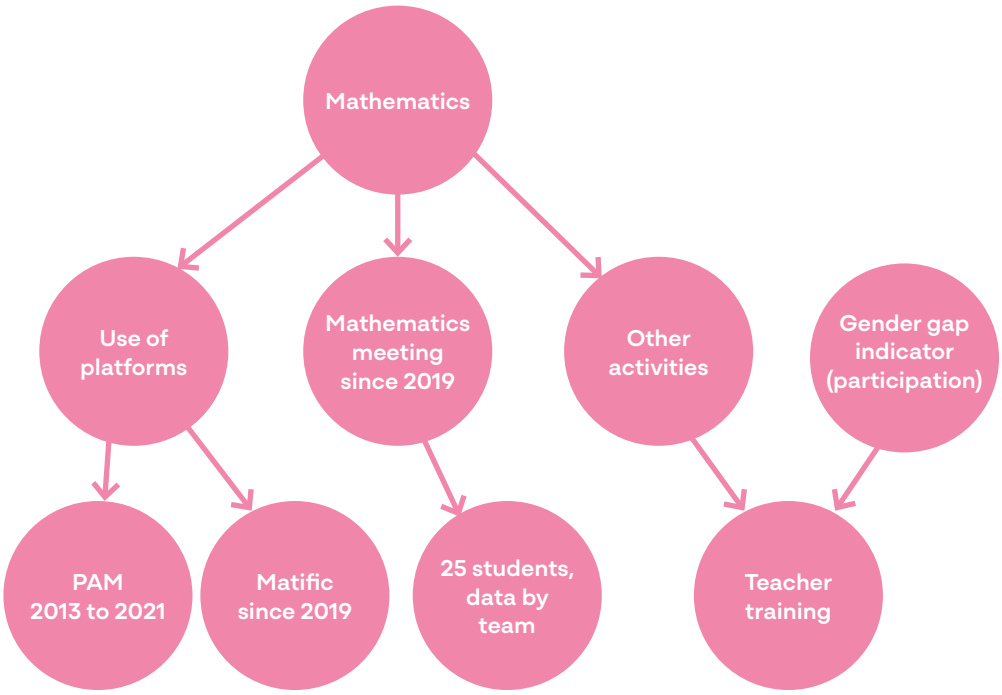


Fig. 2.5: Mathematics

The platforms unit aims at becoming a tool available to teachers. Its use is included in Ceibal Observatory data[3].

PAM

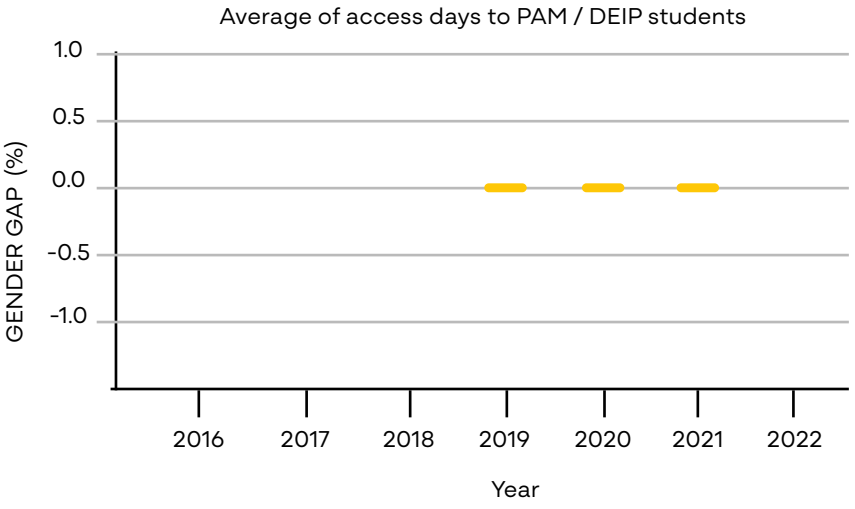
PAM is an adaptive online platform to teach mathematics that actively integrates students and teachers in the education process. It provides teachers with tools to work with their groups, establish learning goals and propose activities. It offers comprehensive assessment instruments to provide monitoring and create reports on the spot. It allows teachers to create activity sets and share them with colleagues.

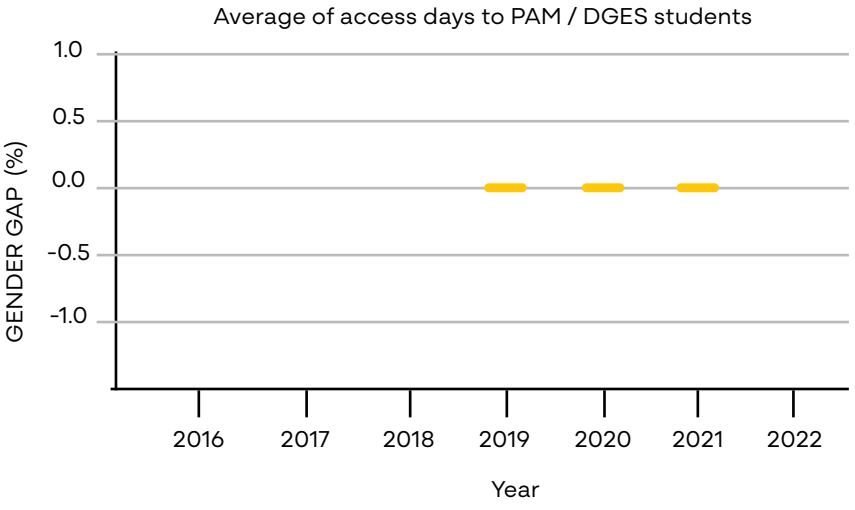
Since 2013, the Uruguayan education system has a tool designed for adaptive learning in mathematics: the Adaptive Mathematics Platform (PAM, by its Spanish acronym). The contents of the PAM are adapted to the national curriculum and are a tool that, based on the analysis of the students' experiences, offers custom responses based on their skill sets. The use of PAM has broadened across the education system. **In 2016, approximately half of the students between 3rd and 6th forms in primary education had used the platform.** The results of the study show a

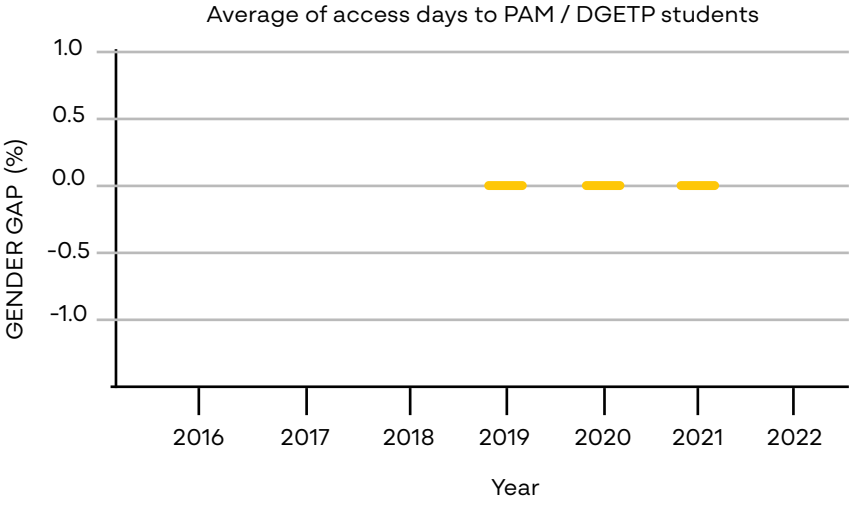
[3] https://observatorio.ceibal.edu.uy

positive, significant effect of a 0.2 standard deviation in the learning gains (CINVE, 2017.)

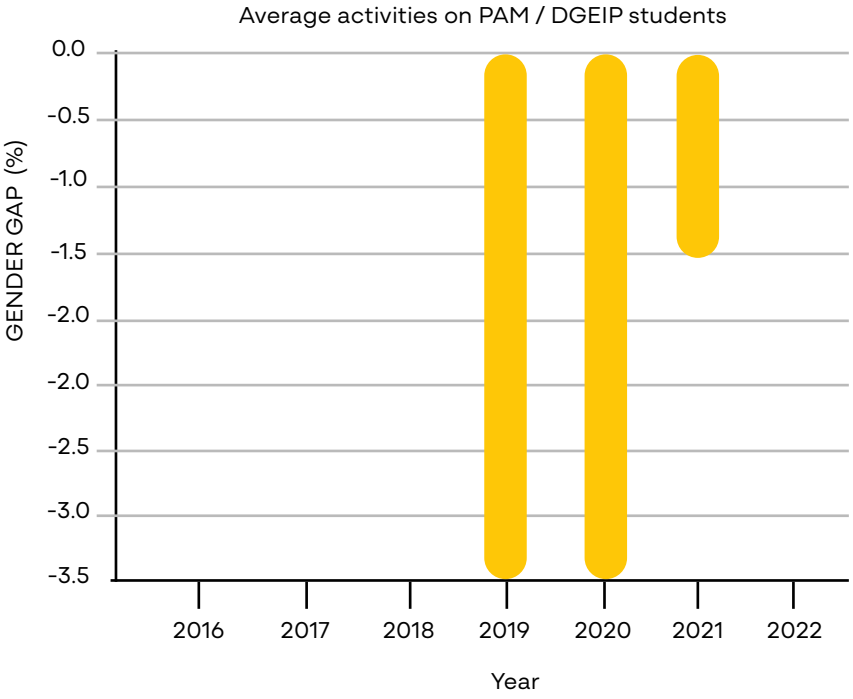
- Information on the use of platforms is available on Ceibal Data Observatory.

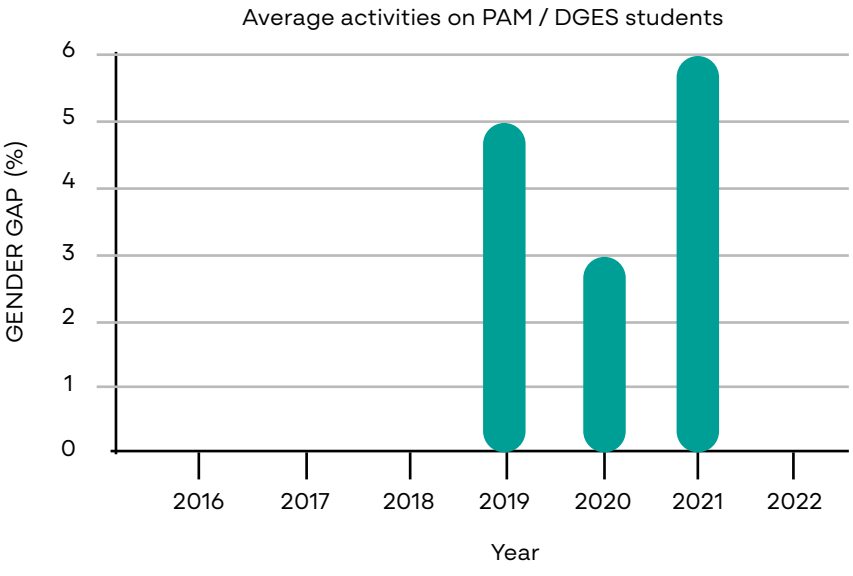


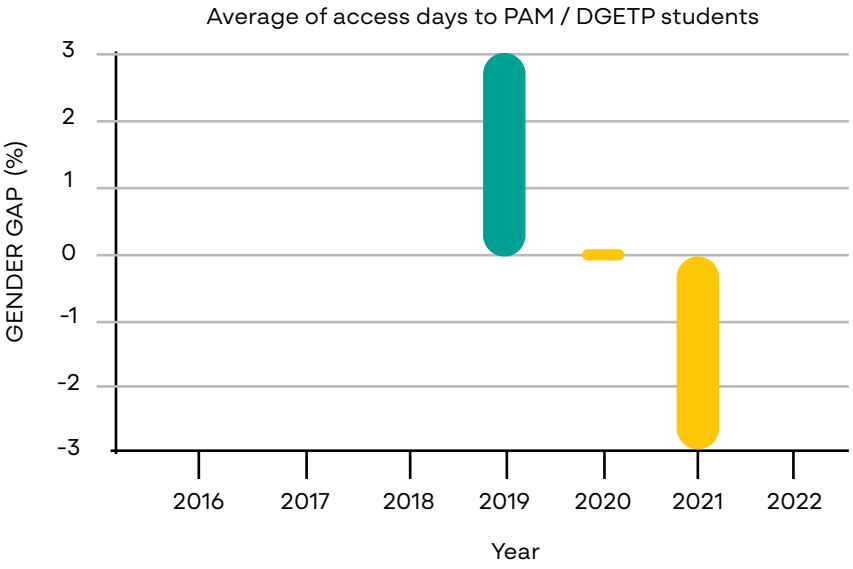




Gender gap visualizations in the average number of activities on PAM platform for primary, secondary and technical-professional education are shown. The gap is favorable to girls in primary education and favorable to boys in secondary education.







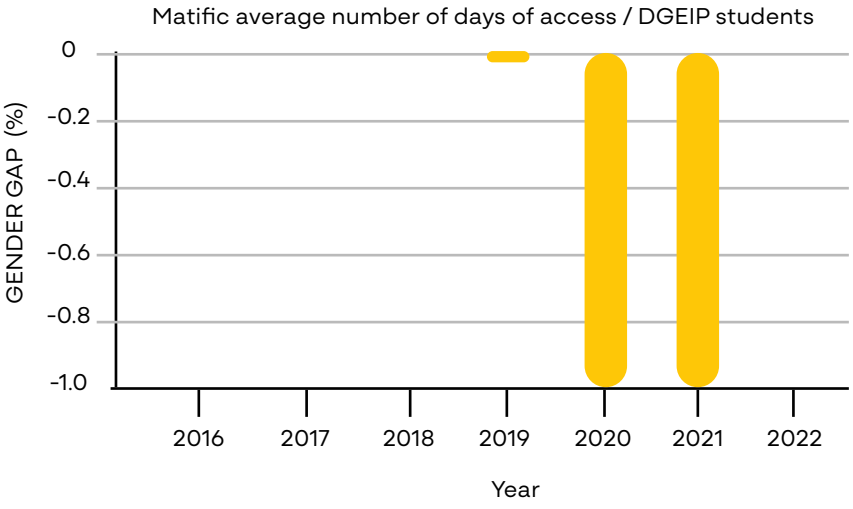
Information on attendance to mathematics events is available by team, not by person.

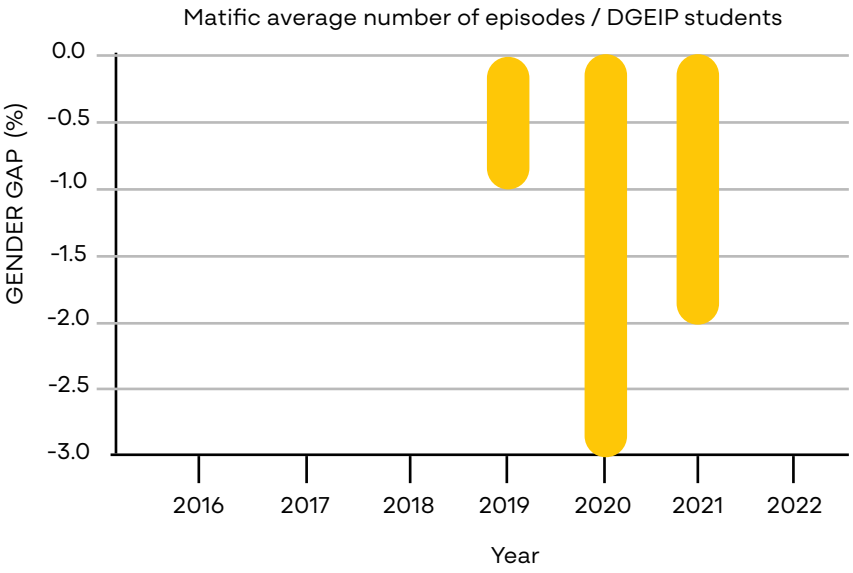
Matific

It is an education platform for teaching and learning mathematics geared for students and teachers since "Pre-primary level 5" to 6th grade in primary school. It is a tool that complements the teacher's work, functioning as an effective, attractive tool that additionally allows teachers to monitor each student.

The following indicators are available (for primary education only):

- average number of days of access,
- average number of episodes.



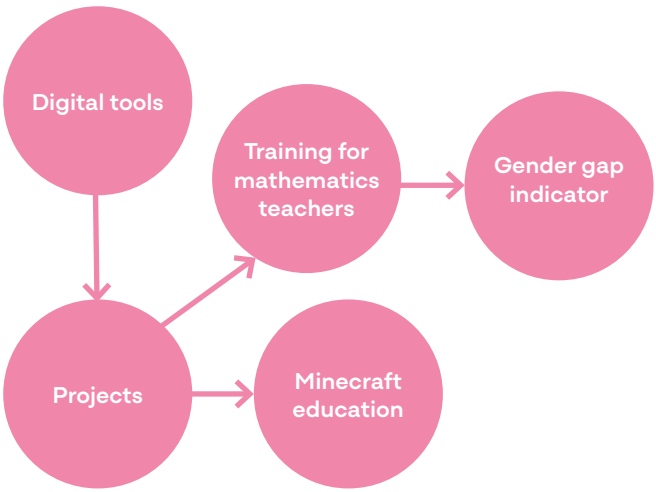


Although there is virtually no gender gap in access to Matific (1% favorable to girls), there is a gender gap favorable to girls (3%) in the average number of episodes (educational instances) performed.

- Information on the use of platforms is available on Ceibal Data Observatory.
- Information on attendance to mathematics events is available by team, not by person.

Projects

Ceibal's digital tools projects include Minecraft Education and math training.



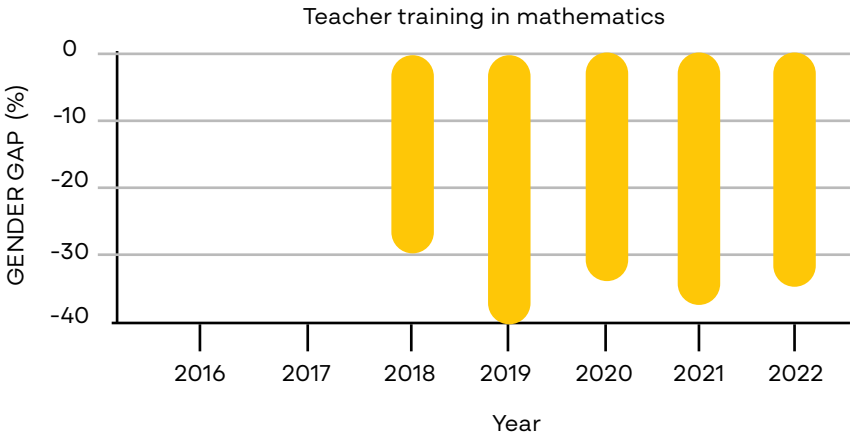
Minecraft Education

Minecraft Education aims to foster project-based learning, collaboration, creativity and teamwork in the classroom. This tool, named after the popular game, is available for computers with Windows and both, students and teachers, can access it through their CREA users, which allow them to publish and access content, tutorials, forums and chat rooms on Minecraft Education Edition on the platform.

Training in mathematics

The document shows the gender gap in the number of teachers in primary and middle school, and teacher training students who have participated in training sessions during the first quarter of 2022.

It is reasonable to find a gender gap in teacher education favorable to women,



The figures for 2022 are provisional (the indicator has been calculated before the completion of training activities for the current year). The gender gap is favorable to women.

The gender gap indicator in mathematics training is weighted by the different base rate of teachers in each educational subsystem (see box).

Base-rate adjustment

In order to present gender gaps in teacher participation in mathematics training sessions, a series of steps were taken before calculating the gap to take into account the different proportions of teachers by gender. Teaching is a female-dominated field, with an approximate ratio of 3 to 1.

To calculate teacher participation gender gap taking into account the base rate, the calculation is as follows:

1. Calculate the proportion of participating female teachers in the total number of female teachers. Let's call that result A.

2. Calculate the proportion of participating male teachers over the total number of male teachers. Let's call that result B.

3. Let's calculate the gender gap as the value resulting from applying the formula and express that result as a percentage. (B-A)/(B+A)

interfaces with educational content

Additionally, Ceibal has interfaces with educational content through the Biblioteca País, Valijas and Videogames.

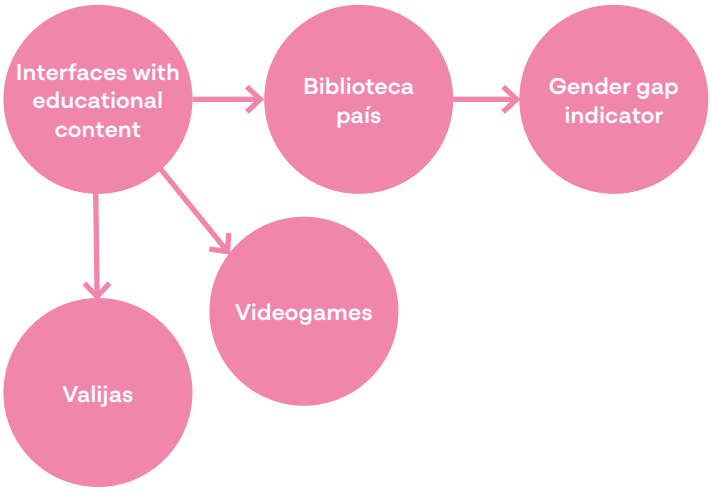


Fig. 2.6: Educational interfaces

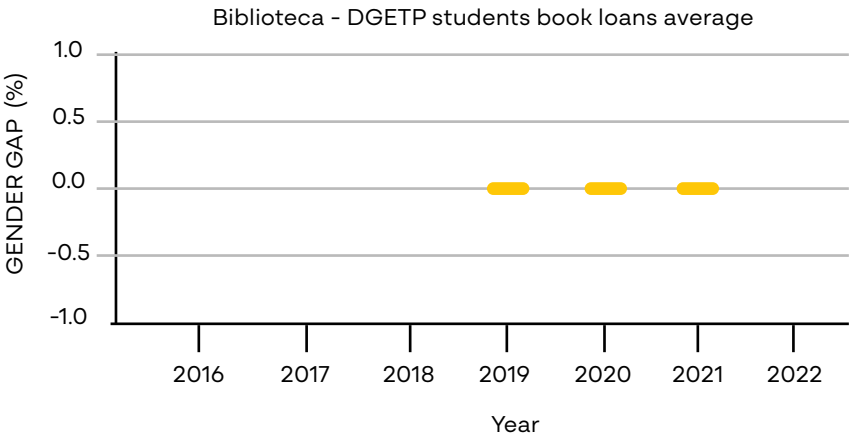
Biblioteca País

Biblioteca País seeks to make access to reading and culture democratic through a wide selection of content of interest to the educational community and the general public made available for free and from any device. For students and

teachers, the platform offers written material and education books in the STEM fields.

The gender gap indicator for the student population (by educational subsystem) is available in the following dimensions:

- percentage of access coverage,
- average number of days of access,
- loan average



There are no gender gaps in the calculated indicators. Only the average book loans indicator for technical-vocational education is shown.

The same indicators are available for the teaching population.

Valijas

Valijas is an online microsite that offers customized free-to-use applications and platforms for non-specialized users which are specially selected based on the digital skills and abilities they imply and promote.

This is a selected resource site that includes free, online or downloadable tools for primary and secondary education teachers and students. Having multiple resources readily available for educational communities allows for creating multiple teaching and learning combinations and processes of an innovative, creative nature.

It has over 150 resources organized by categories, facilitating the creation of educational resources in digital environments that support the virtual and face-to-face teaching and learning strategies.

Additionally, it allows people to look for tools to create presentations, forms, images, maps, websites, as well as to edit videos and sounds, store information, develop games and do more.

Videogames

- Applications for primary education

Educational applications and games for tablets in first and second forms, primary school.

- Applications for secondary education

Educational applications and games for middle school tablets (1st to 3rd years high school.)

Jóvenes a Programar (JaP)

This section organizes quantitative and qualitative evidence on the effect of the Jóvenes a Programar (JAP) program by gender.[1]

Jóvenes a Programar (JaP) is a program by Ceibal providing youth between the ages of 18 to 30 across the country with training in programming and testing. English and socioemotional skills are also taught as part of the curriculum. JaP creates opportunities, builds the present and the future, transforms realities and helps people get jobs in the area of information and communication technologies (ICTs).

JaP is a flagship program for Ceibal because since its inception in 2017 it has based decision-making on empirical evidence, with a high-quality approach to data creation and measurement.

When highlighting the activities of JaP one can extract tools and recommendations to actively monitor the program, as well as test the theory of change and, in as much as possible, extrapolate proposals from other programs.

Given the question of whether **this program reduces, maintains or increases gender inequalities between men and women**, the immediate answer is that the program has reduced and actively seeks to reduce gender inequalities between men and women.

Since its inception, JaP is a program seeking to promote equal opportunities and socioeconomic, geographic and gender equality. Figure 1.9 shows the most noteworthy characteristics in the JaP design.

The main objective of the program is to provide training in programming and testing for youth given the high demand of these specializations in the ICT sector, with zero unemployment.

As a second main idea, the program facilitates the reinsertion of NEETs (people not in education, employment or training) into the formal education system.

[3] Additionally, JaP decreases many other inequalities: in access, providing opportunities to the low and low-middle income quintiles; and geographical, by reaching urban communities far removed from department capitals and rural fields. This is partly due to the promotion of the synchronous-remote teaching model which became very widespread since 2020 during the COVID-19 pandemic. Although the work is not focused on this, those achievements do breed equal opportunities for youth worth noting.

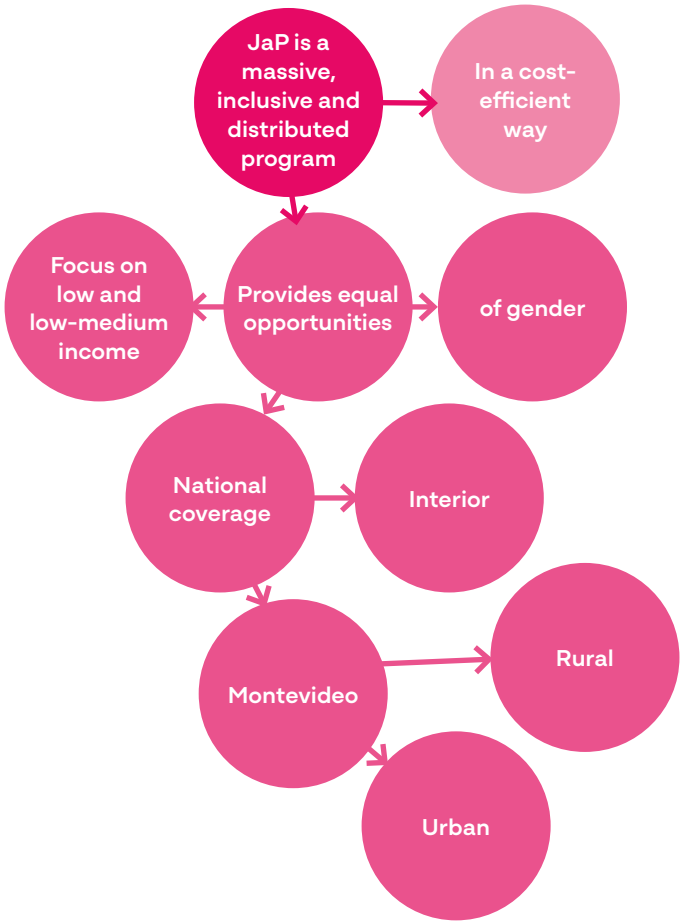


Fig. 2.6: 2.6: JaP design characteristics.

Success factors

There are mainly four factors explaining the success of the JaP model: a **training model** integrating technical abilities with cross-cutting skills (teamwork, integrating solutions, solving conflicts) and English.

The strategic direction of the program, led by an engineer of international experience, generated a fluent relationship with the technology sector (Cámara Uruguaya de Tecnologías de la Información) in which suggestions and recommendations are heard and implemented and **coordination issues are resolved**.

From the beginning, the lean start-up model with a constant review of processes, together with **a high capacity for implementing, executing and making decisions based on empirical evidence**, has led to a continuous review of the teaching and learning model until arriving at a scalable solution. In addition to this review, there is an organic growth of the work team, with a **strong commitment for the performance and achievements of students** (see Fig. 1.10.)

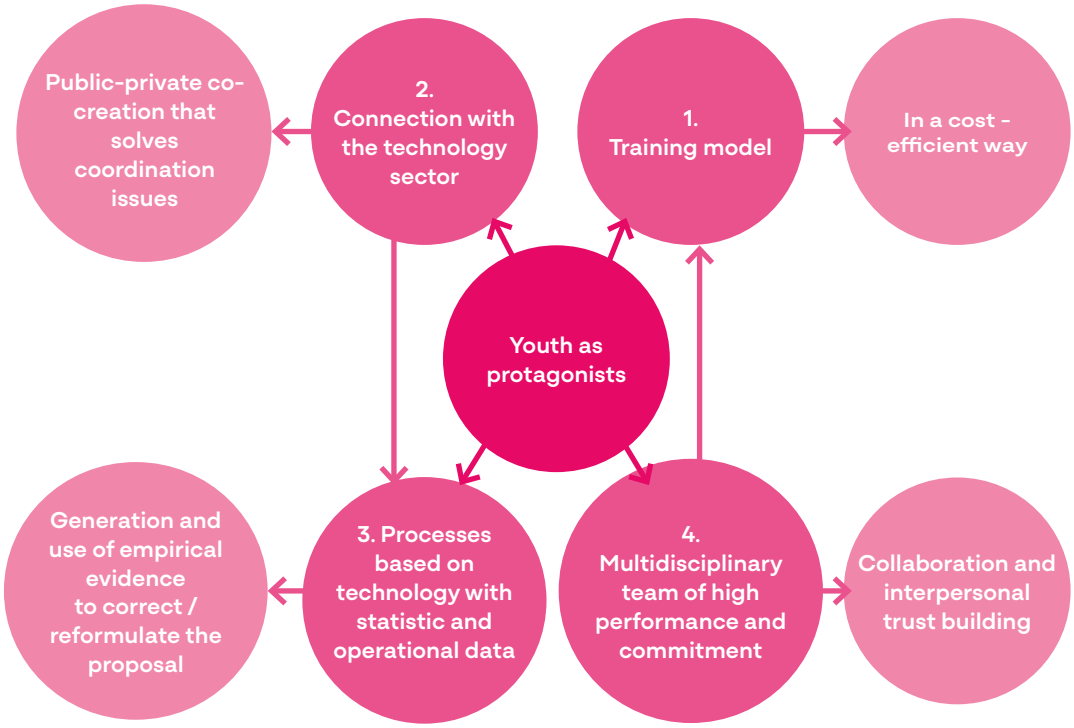


Fig. 2.7: Factors explaining the success of the JaP model.

JaP achievements

JJaP creates markets.

JaP solves coordination issues.

JaP contributed to creating a new institutionalism.

JaP benefits the whole of society.

Market creation

Markets do not appear spontaneously, but rather they are promoted or destroyed by the activities of people.

New markets are created when people (agents) detect, either by accident or design, a latent need and share their solution for that need: markets appear when financial stakeholders move resources for the solution of that company.

The clearest way to create a new market is offering a novel product or service, thus meeting unsatisfied (and even undetected) needs.

The most important thing to create a market is to have **vision**, that is the ability to imagine something that does not yet exist.

Companies do(did) not ask for junior profiles, the education sector did not offer this profile.

JaP solves a negative externality (presence of NEET youth) by creating a pilot market for a secondary asset.

Ceibal operates as an organization that brings together organizations that take risk on (IDB, CUTI, INEFOP) and minimize it through a massive, inclusive and diversified proposal.

Ceibal also provides a vision as to how to improve the world: (re)inserting youth in formal education through technologies in high demand, such as programming and testing, which **directly** favors people as they receive quality education in a high-demand sector. This a) motivates them to continue studying and b) facilitates their entry into high productivity jobs. Additionally, this **benefits all of the economy**, since, on the one hand, these people who are now studying are no longer inactive in the labor market, thus decreasing the burden for the State and, on the other, they are included in the productive sector.

JaP has not only **transformed the life of graduates**, reinserting them either in the labor market or the formal education system, but has also given them a **voice and the possibility to participate in decision-making processes** (agency), thus achieving a **positive, significant effect** in work decisions at a **low cost per student**.

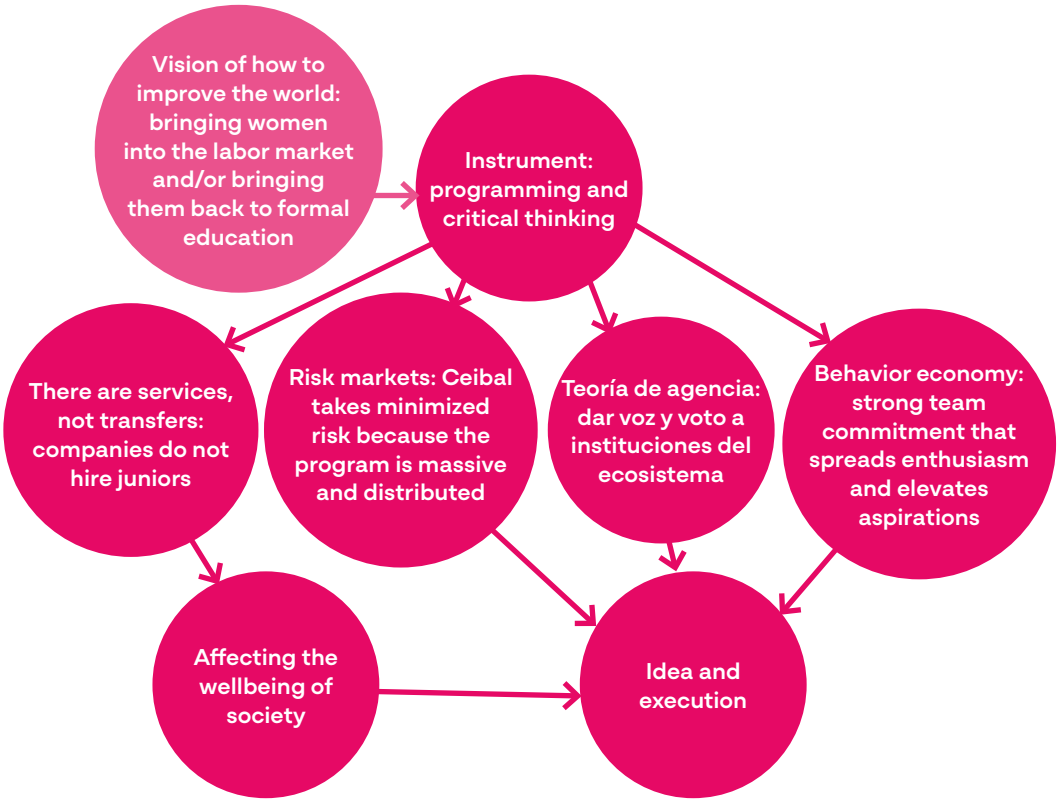


Fig. 2.8: Market creation.

Resolving coordination issues

Software companies said they were helping train junior profiles, but did not hire them since, just as it happened with other companies in general, they could not identity their value. JaP has explained and shown the value of having junior and senior profiles in an organization, working in collaboration.

"You are two times more likely to work in the industry after JaP."

Fiorella Haim

Focus on actions; evidenced-based decisions, positive discrimination[2]

Through time, by looking at boys and girls who were not similarly interested in the proposal, and considering that STEM is a highly productive sector paying high salaries and allowing for flexible hours, JaP has applied multiple measures looking to favor gender equality:

- entry tests with different times by gender;
- exclusively female cohort (2019);
- use of inclusive language and icons to foster gender parity at enrollment.

Efficient, inclusive and egalitarian model

The third edition of the JaP program exclusively targeted women. With that experience, it was possible to achieve a global graduation percentage (out of the three editions) out of 44%. In a study on the continuity in study or work in the IT area, it was seen that graduates from the program tripled this number in comparison with the control group (source: https://www.youtube.com/watch?v=xoCf2Nd- Cws4).

[2] Link: https://www.youtube.com/watch?v=3YB4ycuxg6A

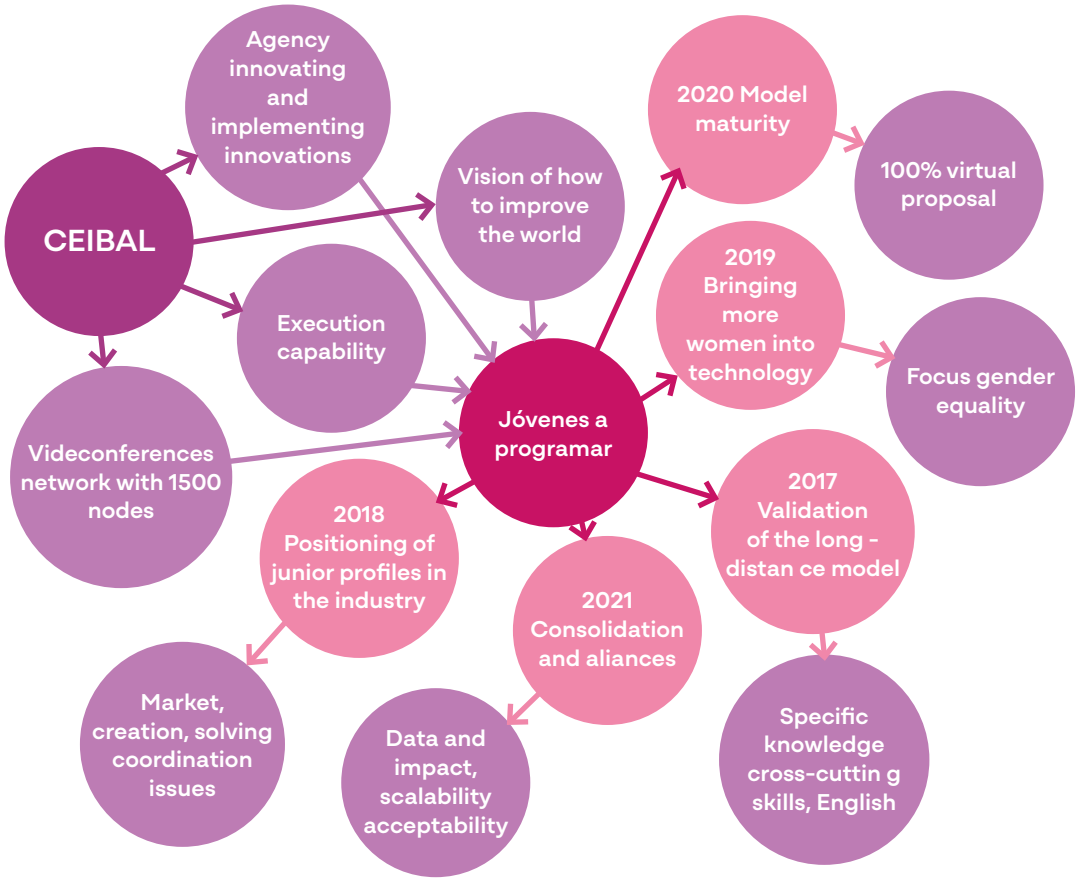


Fig. 2.9: Specific strengths of Ceibal for JaP

New institutionalism

Through data analysis and resolving the coordination issues, JaP has managed to increase efficiency in the use of public funds, where the insertion of massive training projects in the region was between 5-10%. In JaP the figure is 36% in ICT jobs. This was done by collaborating with existing education institutions and creating a new institutionalism to support the insertion of youth, making the complimentary role of junior and senior profiles explicit, using data analysis and mathematical tools to help youth come close to the ICT sector, and providing the youth with cross-cutting and technical training skills.

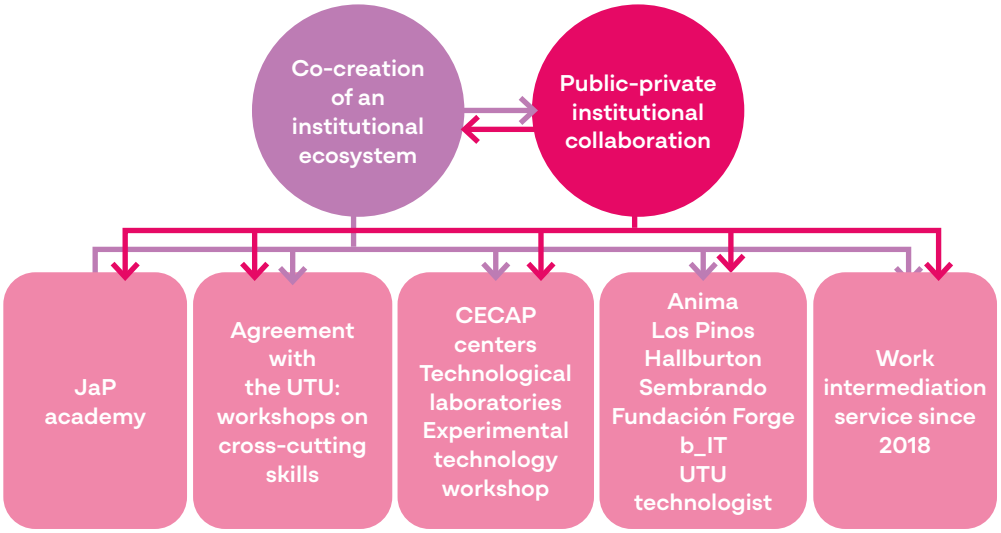


Fig. 2.10: New institutionalism created at the initiative

Benefits for all society

The first measure from the program with positive effects is that, since its inception in 2017 and up to 2021, 3,200 young people have graduated.

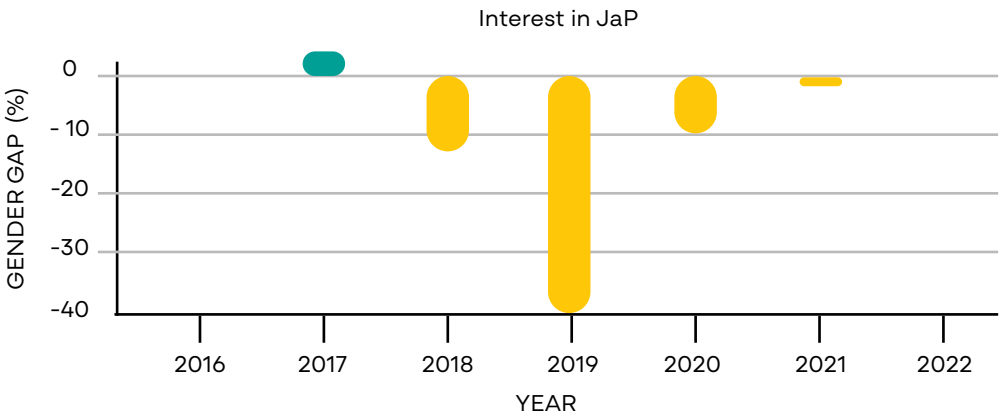
Secondly, 48% of graduates from JaP have reached tertiary education, in comparison to a 30% in the control group.

Thirdly, JaP has achieved 56% of workplace integration, with a 36% integration in technological works.

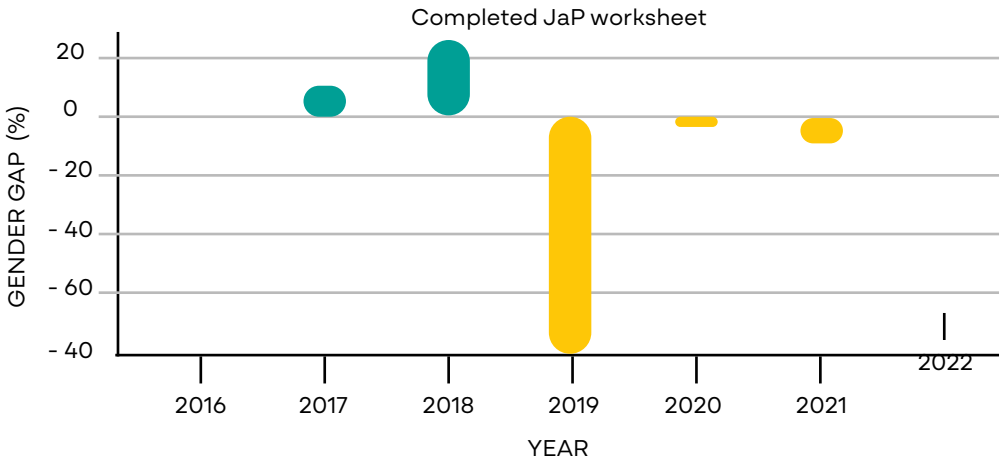
Focusing on a problem, JaP uses data science to support the workplace integration of youth, creating jobs and contributing to the productive development of the country..

Four indicators and their visualizations were selected for this work.

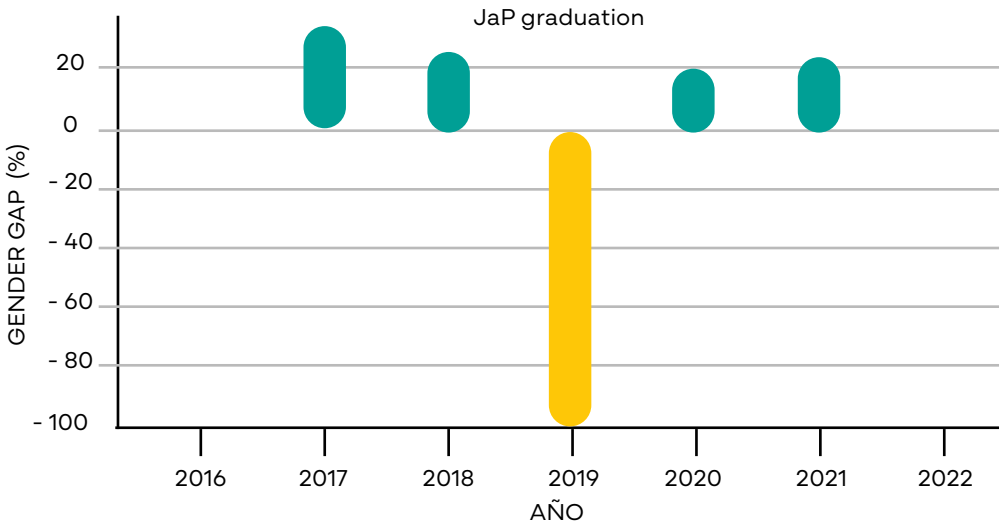
1. Showing interest in the JaP program



2. Enrollment to entry test (completing the student worksheet)

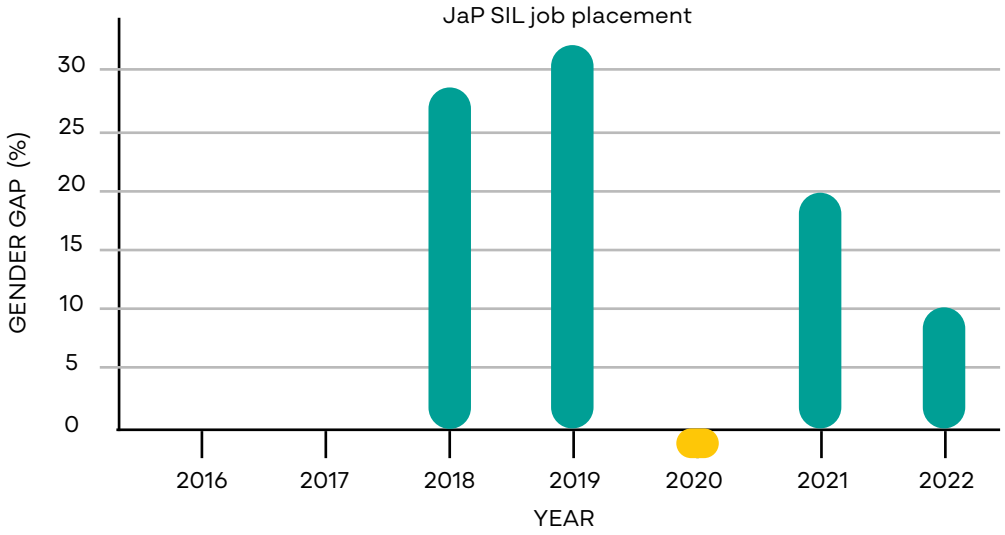


3. Number of graduates



The number of graduated women has been constantly increasing in time.

4. Integration in the labor market



Results

- Women without children pass at a larger scale than men with children. The gap is maternity or paternity, not gender.
- As time goes by, it is seen that people showing interest or enrolling have completed more years in formal education (most finished high school.)
- In 2022, 74% of men and 49% of women passed the entry test. In previous years, the gap observed was lower (mostly because 59% of women passed.)
- In terms of accumulated graduations, 40% of graduates are women, which can mostly be explained by the fact that the 2019 generation was exclusively made up of women.
- A positive "contagion" effect was observed in the 2020 generation, yet it decreased and slowed down with time. It is similar to the figures observed in the industry.

Proposals to continue increasing inclusion in underprivileged groups

- To assess if the performance of groups of only one gender is different from that of mixed groups, the proposal is to compare the results from groups of only one gender from those of mixed groups (like with other observable characteristics.)
- To pass onto the next training stage (phase 2), it is proposed that, rather than having the students with the best grades passing (which would maintain the initially existing inequities), groups should be organized based on observable characteristics people cannot control (socioeconomic level of parents, geographic location) and the same amount of people from each subgroup should pass, then organized according to the grades obtained in the final test of phase 1.

In this way, initial inequities are partially remedied.

Computational thinking

The Computational Thinking (CT) program is a videoconference teaching program. Once a week, a teacher working remotely connects to the classrooms and teaches a class together with the teacher physically in the classroom. CT works in the resolution of complex problems using programming logic. Interdisciplinary work is conducted in different fields of knowledge, such as mathematics, language, sciences, arts and physical education. The program is voluntary, and teachers and students must enroll to participate.

In 2020, 2,047 groups from years 4, 5 and 6 of primary school belonging to 627 education centers were enrolled. In 2021 and due to the pandemic, work was conducted with 1,300 groups from 485 schools across the country. The target population for 2020 were students in years 4, 5 and 6 of primary school. In 2021, the scope of the intervention was broadened to year 1 in middle school.

Program objectives

Computational thinking is a methodology working on **the capacity for abstraction, finding patterns, organizing things in operational terms and identifying parts of a problem**, skills that one may apply to diverse situations and that include and exceed the task of programming in computers.

> In its practice, Ceibal considers a definition that considers computational thinking as the skill to maintain aspects of the real world that may be modeled as problems and design and assess algorithmic solutions that may be computationally implemented (Fraillon et al., 2019.) Computational thinking is understood as a way to reason and solve problems using the logic of computer science. In that context, the aim is for students to learn foundational contents for computer science and learn new approaches to problem resolution taking advantage of the potential of computational thinking, so that they mightbe users and creators of the technology of the present and the future.

Computational thinking is a 21 st Century skill connected to the six skills of the Red Global de Aprendizajes: **character, critical thinking, creativity, communication, collaboration and citizenship**.

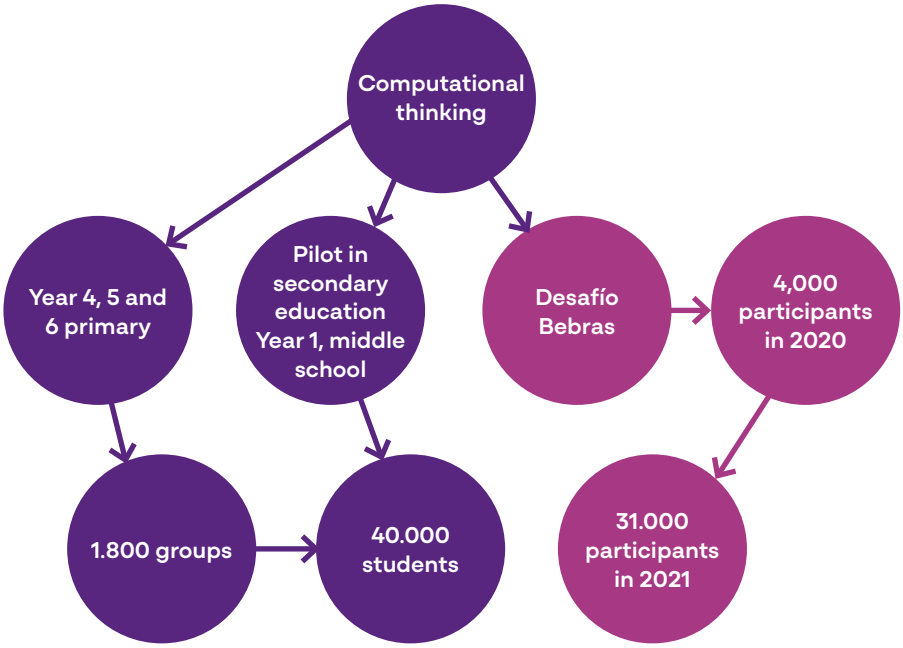


Fig. 2.11: Computational thinking.

Computational thinking in primary education

Work is conducted with groups from years 4 to 6.

The program design engages workshop facilitators, remote teachers and classroom teachers who jointly cover the pedagogical proposal integrating the contents of the curriculum specific to computational thinking as well as the interests of the students. The program comprises weekly cycles in 45-minutes classes.

Pilot projects for CT in high school

In high school (secondary school and UTU), a pilot project (called PC + MAT) was developed with the participation of Year 1 students from high school together with their mathematics teachers.

The aim is to jointly display the mathematics and computational thinking projects by Ceibal. Each mathematics teacher is responsible for leading the project which is divided into seasons and episodes. The project is based on understanding and solving mathematics activities integrated with computational thinking, especially in the programming area.

Bebras challenge

Bebras (meaning beaver in Lithuanian) is an international challenge in which students from year 3 in primary school to year 3 in middle school participate in a training focused on skills necessary to solve problems.

The challenge has categories by age:

- Little ones (8 to 10 years.)
- Beavers (11 to 12 years.)
- Cadettes (13 years or more.)

Out of the 50 participating countries, the only one with a beaver is Uruguay. Her name is Dai.

Relevance

Ceibal gets data in three stages:

- enrollments,
- CREA activities,
- Bebras challenge.

On the enrollments to computational thinking, Ceibal has two data bases:

1. Groups effectively participating

For those groups, Ceibal has data from the identity card and the Ceibal code. Those data can be associated to the participants to see all the information for each student or teacher. This allows for generating information both by gender as well as by other segments or intersections.

2. Report on enrollments: information on who registered the group and information on the person in charge of the teachers (supervising teacher.)[1]

[1] Dada la alta proporción de mujeres en magisterio, se usa el femenino genérico, incluyendo a los maestros.

- Data has limitations.
- Data from previous years is available albeit it is necessary to check which data is most up to date.
- The historical record of those who enrolled and dropped out is not available.
- Among the limitations in the data from the Bebras Challenge are:
- These data do not consider the possible differences between face to face and virtual instances caused by the pandemic.
- Data is available for the May-December 2021 period.
- There is data on whether people spoke during the videoconference but not on how much they
- spoke (maybe they simply said "present", for example, so it is not useful for the analysis.).

Access to and control of resources

This works on rules and values. Teachers enroll voluntarily.[2]

STEM teaching and learning

Creating participant groups by gender, 2019-2022

Percentages are calculated over the total number of students enrolled in Primary school to avoid biases in gender distribution in Primary in general (especially in teachers.)

In 2019 and in the case of the students, 9% of all girls enrolled in Primary participated in Computational Thinking in comparison to 8% of boys enrolled. In 2020, in both cases the percentage was 8%, and in 2021, the percentage was 8% in girls against 10% out of all boys. This last year, the percentages were matched, and its 15% for both boys and girls.

In 2019 and in the case of the teachers, 12% of all male teachers participated, while 8% of female teachers did. In 2020, 5% of all female primary teachers participated in Computational Thinking, while 4% of male teachers did; in 2021, it was 8% of female teachers and 6% of male teachers and, in this last year, it was 12% of female teachers versus 10% of male teachers.

It should be noted that those enrolled in Computational Thinking (either teachers or reference points in the education center) enroll the entire group, so it is not up to the students to participate, but rather each student from the group enrolled participates.

[2] https://www.ceibal.edu.uy/es/articulo/institucional/sala-de-prensa/pensamiento-computacional-lanza-inscripciones-para-el-2021

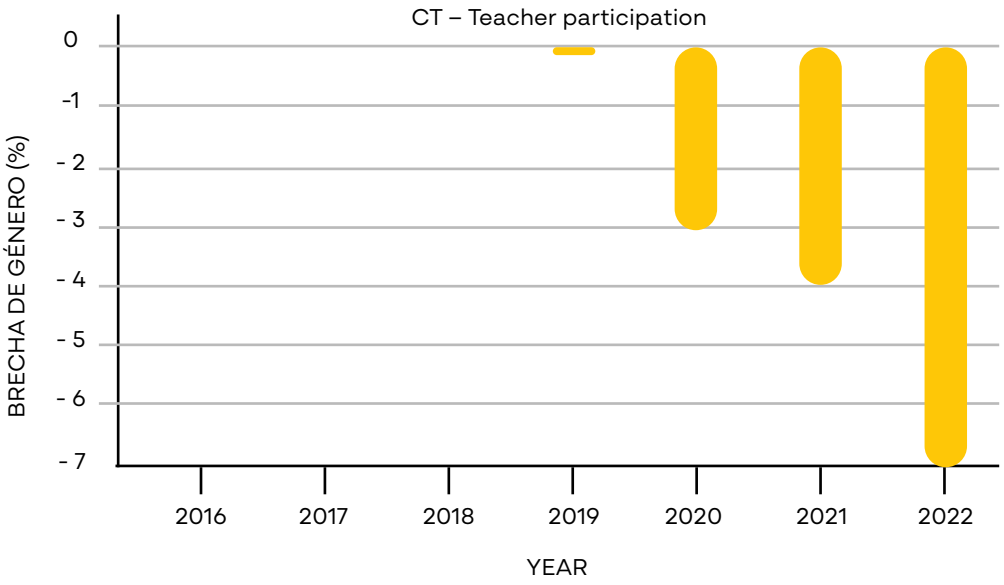
Decisions and power

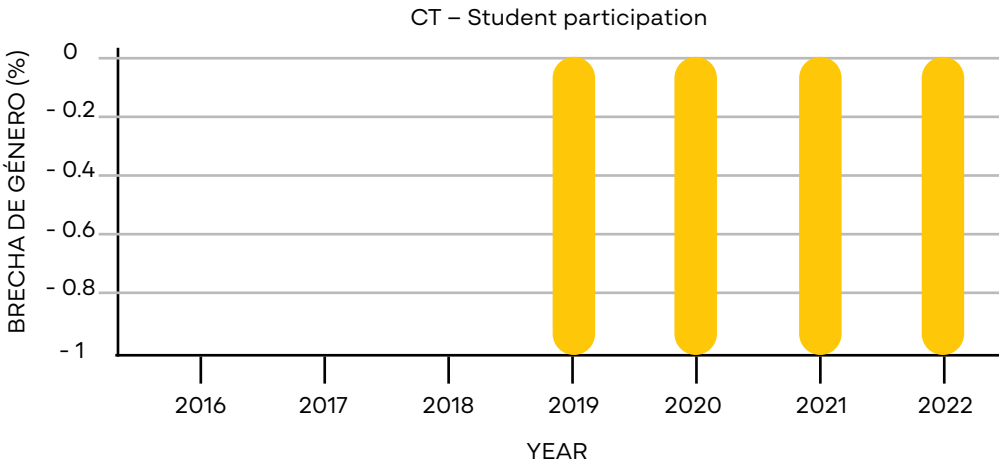
Each remote learning teacher actively promotes the participation of girls.

Assessment tools are included in the rules for remote teachers.

Guidelines for remote teaching

- Remote teachers must consider the diversity of each student in the classroom and work to promote a positive, inclusive learning environment.
- Remote teachers must establish routines and use given names to create a safe learning environment and build a good rapport.
- Whenever possible, and considering the furnishing and physical space, the seating arrangement must be beneficial to the STEM teaching and learning process.
- Remote teachers must facilitate the development of values and the civic behavior of students: respect, equality, honesty and cooperation.
- Remote teachers must establish routines to foster the autonomy of students and independent learning habits. Examples of routines:
  - hand raising,
  - listening to others,
  - waiting for turns,
  - preparing materials for the session beforehand.
- Remote teachers must establish clear boundaries and rules, and create an environment of protection, well-being and equality so that students feel safe in class.





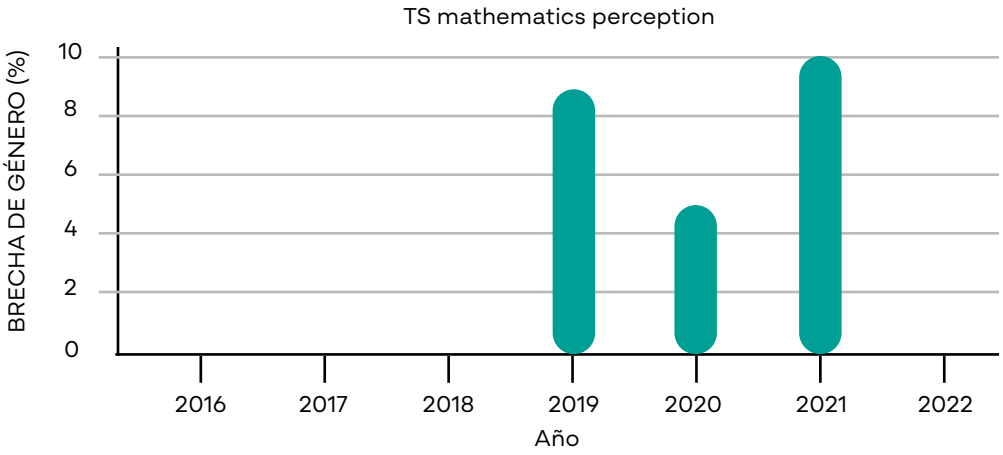
Surveys on teacher participation

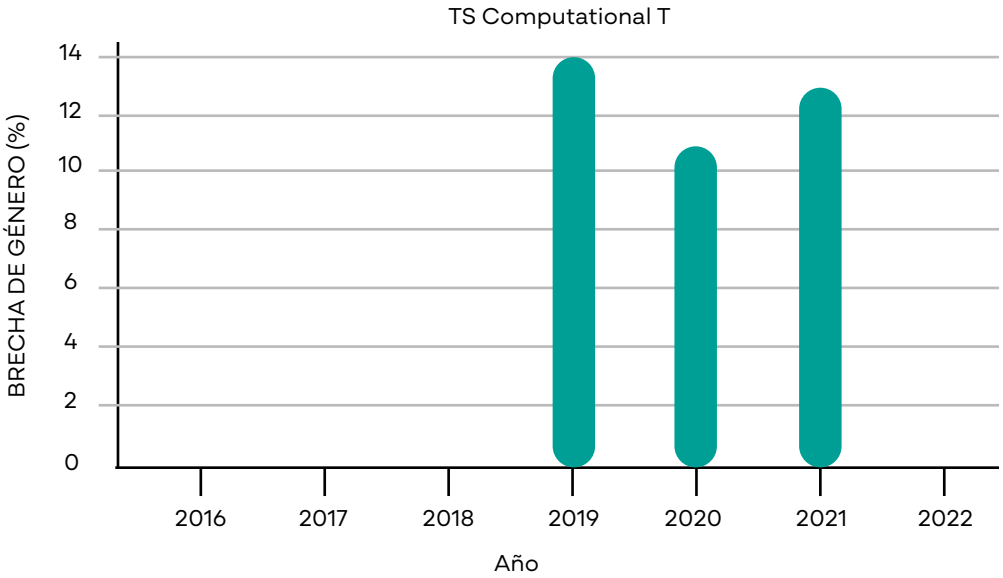
Among the digital tools, the results for the gender gap indicator in the surveys on teacher perception are included.

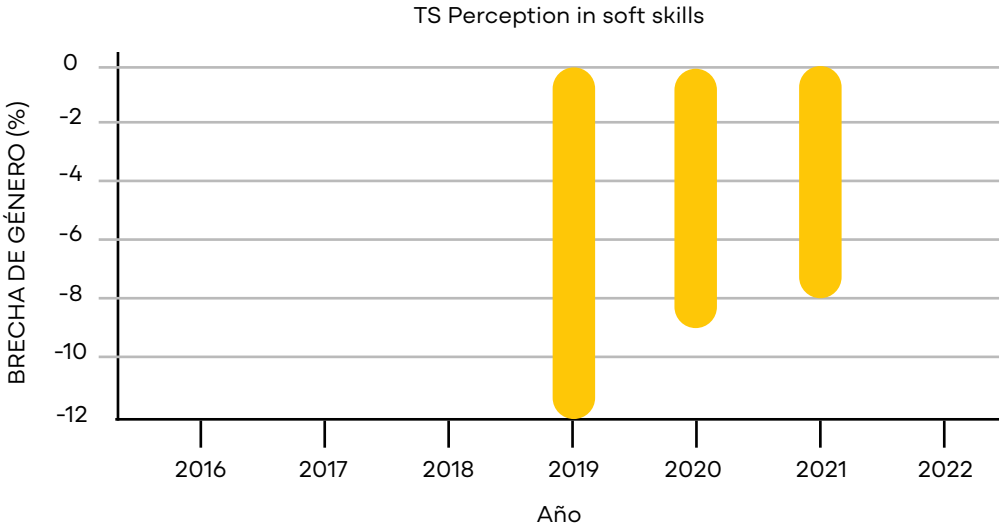
Information is available since 2019. It is calculated as the sum of the percentage of teachers who responded “more in boys” and “much more in boys” minus the percentage of those who responded “more in girls” and “much more in girls.” The chart shows the questions grouped into four categories: soft skills, language, computational thinking and mathematics.

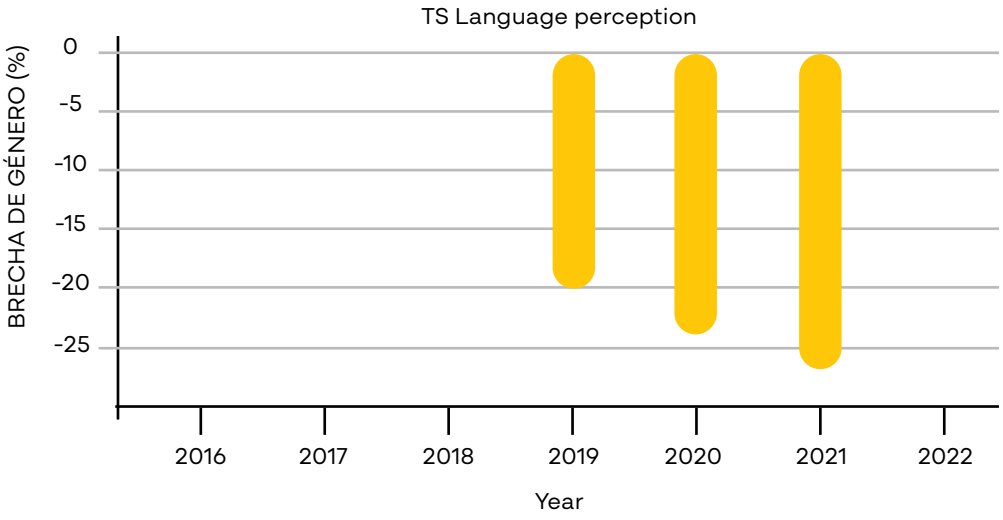
Question	Category
Who learns more from their mistakes?	Soft skills
Who shows more interest in learning?	Soft skills
Who is more collaborative?	Soft skills
Who is more competitive?	Soft skills
Neatness is...	Soft skills
Performance in language is...	Language
Work in language is more developed...	Language
Who displays a more natural talent for mathematics?	Mathematics
Performance in mathematics is...	Mathematics
Problem resolution in mathematics is more developed...	Mathematics
Who likes programming more?	Computational thinking
Who likes programming more?	Computational thinking
Who likes working in computational thinking more?	Computational thinking
Who learns programming more easily?	Computational thinking
Who is better at learning programming?	Computational thinking
Who is more naturally talented in programming?	Computational thinking
Work in computational thinking is more developed...	Computational thinking
Programming in Scratch is more developed...	Computational thinking

Gender gaps favorable to men are observed in **the surveys on teacher perception** in STEM fields, while gaps are favorable to women in non-STEM fields. These perceptions have not been validated by empirical evidence.


TS mathematics perception
BRECHA DE GÉNERO (%)
10
8
6
4
2
0
2016
2017
2018
2019
2020
2021
2022
Año


TS Computational T
BRECHA DE GÉNERO (%)
14
12
10
8
6
4
2
0
2016
2017
2018
2019
2020
2021
2022
Año


TS Perception in soft skills
BRECHA DE GÉNERO (%)
0
-2
-4
-6
-8
-10
-12
2016
2017
2018
2019
2020
2021
2022
Año



Activity in CREA

Historical data on the participation of students in specific CT is available from 2020 onward. Data includes days with access, completion of tasks, task types and participation in forums.

Among the limitations of these data is the absence of assessments. It is impossible to know if the participation in CREA correlates to people actually learning.

To calculate the indicator for activity in CREA, a median is used (in general, the use of CREA presents many atypical observations: few students making great use of the platform and many who use it very little.)

The analysis may be reinforced by calculating:

- income quintiles,
- geographic area.

Olympics of Robotics, programming and videogames

The Robotics, Programming and Videogames Olympics aims at integrating, visualizing and bringing technology to the education program across the country.

Ceibal Olympics is an event in which students across the country create working teams to develop projects, as well as face challenges in a topic that changes every year. Problems are solved using technology tools; activities include programming boards, robots and drones, along with other challenges. Those projects compete in different sessions where they are assessed by a jury.

It has been held annually since 2014.

This program spans across all education levels without gender distinctions yet promoting the participation of girls and teenage girls.

Ceibal selected three indicators to assess the gender gap:

Participants

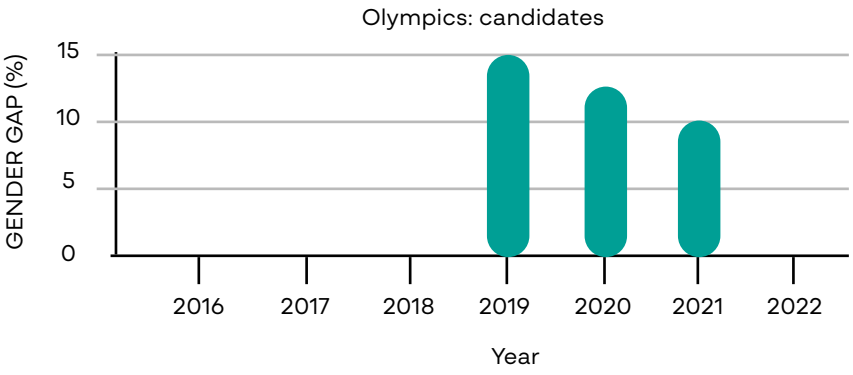
Each member of the teams participates in different stages of their projects, from the registration of the project idea to the presentation of the final product to the jury. Participation information has been recorded since 2016.

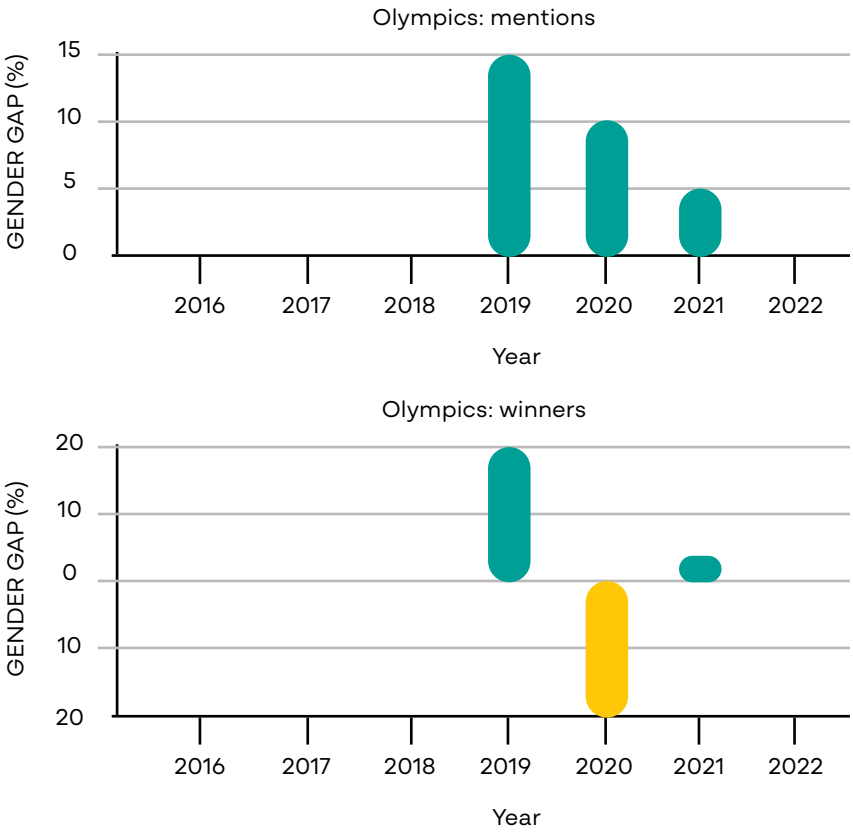
Winning projects, 1st, 2nd or 3rd place

Ceibal has information on the teams that presented outstanding projects and won the 1st, 2nd or 3rd place in each Olympics category; this data has been recorded since 2020.

Special mentions

The special mentions highlight specific aspects of the projects, such as creativity, egree of innovation, quality of research, among others.





Methodology 2021

The following decisions were made to build the indicators:

- To include biological sex data from other sources when that piece was missing from the original;
- there are duplicate identity cards because a person can participate in multiple teams in a single year. In this case, it was defined that the person be counted only once, at the highest level reached in the Olympics.

Changes in methodology for 2022

In 2022, a hybrid mode of participation was implemented; there were virtual and face-to-face instances. The aim was to make the Olympics an annual work process focused on project-based learning. In this sense, for a team to participate it should register an idea and develop a project in the annual Olympics process.

Participating teams may be of arbitrary size according to pedagogical needs defined by the teacher. The requirement is for each team to develop a different project. The groups may have a few or many members (for example, the class may be divided into groups and projects, or it may become one big group working on a shared project). This seeks to integrate the Olympics into the annual curriculum and classroom work.

At data level, this generates (unlike previous years) disparity in the sizes of

participating teams. If a team that gets to the first place is made up of a whole class, that may change relative figures.

Teams go through different stages during the contest leading to the final event, where first, second and third places, and mentions are defined.

Figures for 2022

The 2022 event involved:

- 267 education centers,
- 659 teams,
- 2,315 students,
- 308 teachers.

Short programs

Mathematics Meeting

The general objectives of the Mathematics Meeting are:

- Conducting an event promoting the development of digital skills and the resolution of mathematical problems among teachers and students.
- Promoting a culture of cooperation through collaborative work in small groups.
- Recognizing problem resolution as a cross-cutting skills in the construction of knowledge, especially in mathematics.
- Recognizing and encouraging students who stand out due to their discipline.
- Promoting learning in mathematics as a social and cultural asset.

Traditionally, mathematics competitions have men as their protagonists. From the beginning, the **Mathematics Meeting** seeks to bring mathematics closer to people, so the emphasis has always been on parity in participation.

In the 2019 and 2021 editions (2020 was a virtual event, so no data is available on it), parity could only be verified in the finals, in which mixed attendance was mandatory. As from 2022, year in which a closer focus was placed on the activity of individuals, another objective was to observe the performance of boys and girls beyond the number of participants.

Across the world, STEM fields seek to include more women in their activities, and the Mathematics Meeting is no exception. **As the only mathematics program in Ceibal working directly with students**, this program attempts to foster a collective, collaborative vision on mathematic endeavors to reinvigorate the perception of students on what it means to work in that subject. Thus, the program seeks to create a space where girls may feel welcomed to do mathematics.

The Mathematics Meeting begins in May 2022.

It works with teachers and students on problem resolution.

Expected results

Based on their participation in the Mathematics Meeting, it is expected for boys and girls alike to find mathematics interesting and thrilling, and to be enthused enough so they may work in science and technology in the future.

By having girls interested in science and technology with equal work conditions to those of men, Ceibal provides them with the opportunity of a future where the use of time and responsibilities are equally distributed.

By getting girls excited about working in STEM fields, Ceibal helps them access to better paid, more professional jobs, thus allowing them to use their time as they truly wish. STEM fields are among those best paid; by helping girls access those jobs, they are provided with a concrete chance to obtain better income and work opportunities. By getting girls excited about working in STEM fields, Ceibal helps them access to better paid, more professional jobs, thus allowing them to use their time as they truly wish. STEM fields are among those best paid; by helping girls access those jobs, they are provided with a concrete chance to obtain better income and work opportunities.

Work positions in STEM are not just among the best paid but are also embedded in constantly growing sectors that breed many work opportunities in existing and new fields.

Jobs in STEM are especially masculinized. Stimulating women to join them entails reducing gender segregation in those fields.

The possibility to access better paid, more professional jobs may promote an unavoidable reorganization of the division of labor. By creating more equitable conditions for the access to different positions and better income, it is expected for girls who participate in this program to access more equitable work conditions.

Indirectly, it is also expected for this to decrease violence against women. A higher participation of women in STEM may transform expectations for female roles.

Attendance: between 300 and 400 participants in 2021 (ages 9 to 15.)

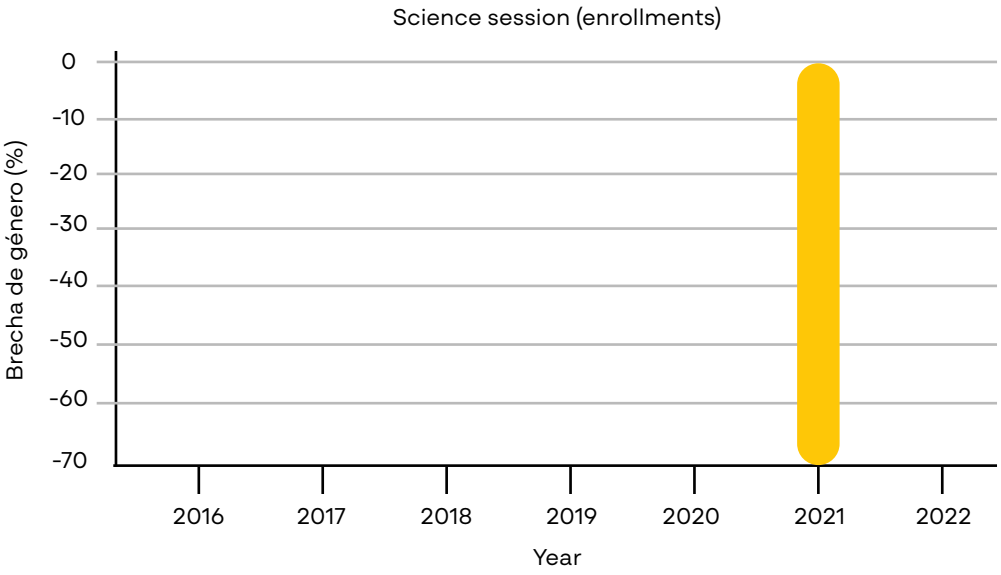
There were between 400 and 500 in 2019.

The program does not have individual results, but rather by team..

Science Session

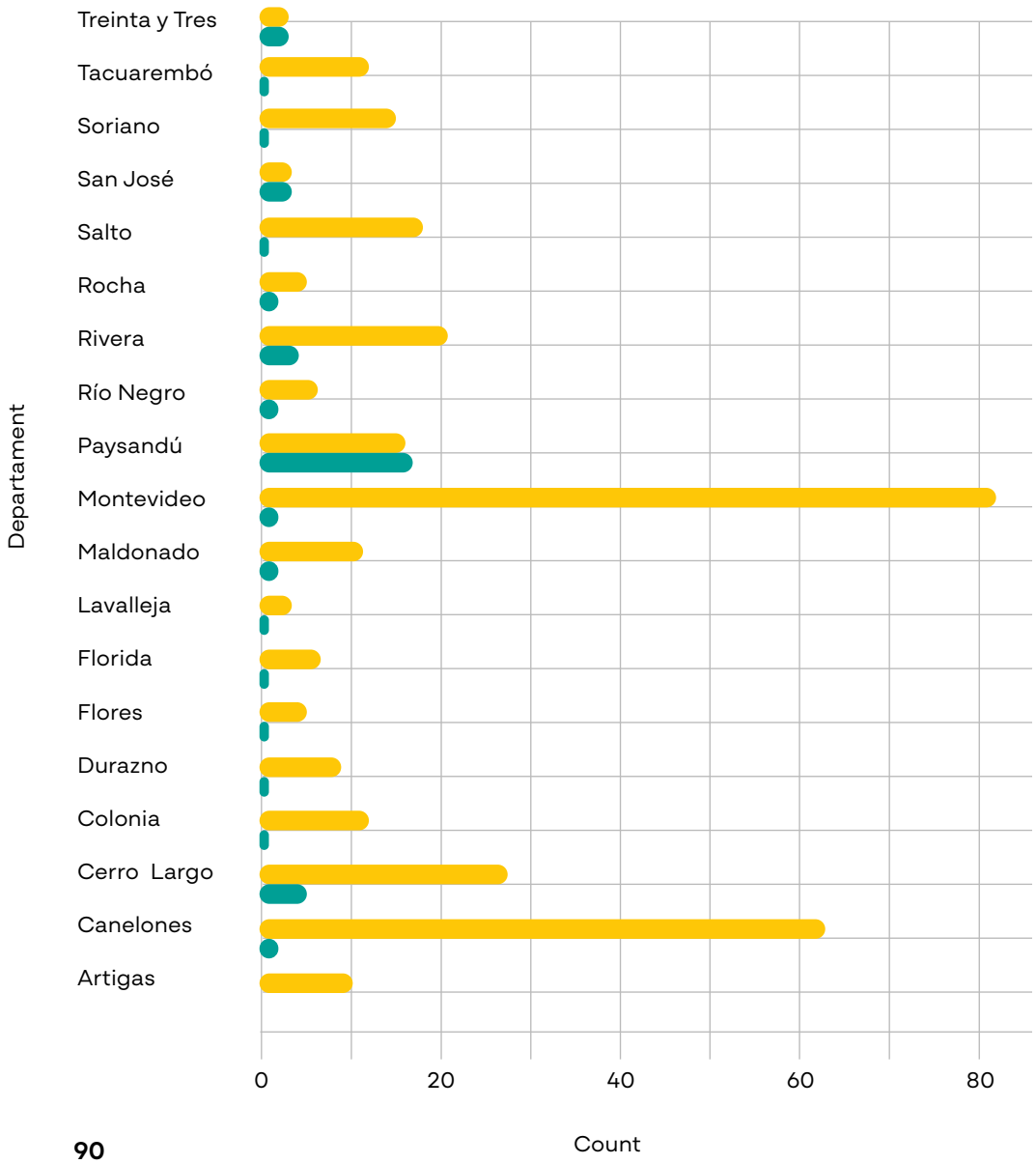
Since 2018, the Science Session is conducted annually, led by the Training Manager.

An interdisciplinary team currently participates in the session (ANEP, Instituto Pasteur, Instituto Clemente Estable). The session includes teachers who voluntary enroll. In 2022, the Science Session was held on Saturday, June 11, and was aligned with the objectives of the United Nations and the UNESCO in the



International Year of Basic Sciences for Sustainable Development.

There are workshops and talks for primary and secondary school teachers.



Digital citizenship

The digital citizenship program refers to the use of technology in that space and seeks to raise awareness about rights, obligations, skills and ways of interacting among people which are constantly negotiated and reconfigured.

Information is available at the class level (teacher enrollment.)

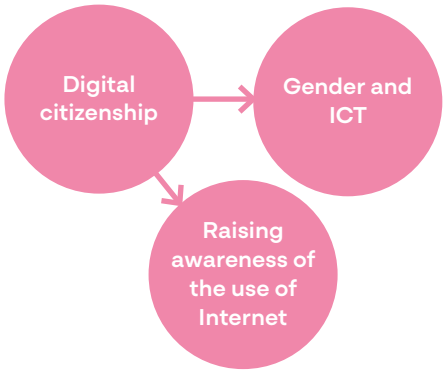


Fig. 2.12: Digital citizenship

Gender and ICT

The Gender and ICT proposal seeks to showcase women who are noteworthy for their entry into the world of ICTs (in a successful or novel manner) to share the different study and work opportunities in technology and incentivize girls, boys and young people to try the area; it was created in 2018..

Gender and ICT pilot project: 2019-2020 report

For the 2019-2020 period, the **Gender and ICT in education** pilot covered the development of Gender and ICT Videoconferences, as well as activities for teachers on the integration of the gender perspective when working with technologies in the classroom.

The Aprender Todos program promotes the **creation of spaces and strategies allowing for a higher appropriation of digital resources** available in Ceibal for learning and social inclusion, through the participatory strategies promoting their significant use.

In this path mediated by the intervention of technology, the equal participation of boys, girls and the youth is promoted so they may exercise a full digital citizenship, as well as to foster the reduction of the gender gap in STEM fields. The program undertakes the challenge of strengthening interventions so they may offer room for the participation of girls, boys and the youth and support teachers in the development of strategies and projects.

Along those lines, Ceibal is part of the Interinstitutional Roundtable of Women in Science, Technology and Innovation, which is part of the International Project of

SAGA-UNESCO. This initiative seeks to Digital citizenship Gender and ICT Raising awareness of the use of Internet contribute to the improvement of the conditions and opportunities for the participation and access of women to different education cycles in fields associated to those fields at all levels of the national research systems and in all productive and institutional structures.

General description of the proposal

The proposal of the **Videoconferences Cycle** entails conducting interviews and exchanges with high-profile women in the field of ICTs (preferably Uruguayan), with the participation of groups of students and teachers through videoconferences.

A woman from the ICT field participates in each session and shares her experience and career in the field with the group of students, who then have an opportunity to ask questions. The proposal implies preparing the group of students to participate in the exchange. Those previous activities are supported on the CREA platform in discussion forums, reference materials and guidance to carry out the activities.

The session is held virtually, with activities in the CREA platform as well as the opportunity to connect to the videoconferences from the comfort of their homes.

The cycle is geared towards students in years 5 and 6 of primary education and years 1 and 2 of middle school, as well as their teachers. The sessions are conducted each year on the fourth Thursday of April, on International Girls in ICT Day, when different activities are carried worldwide to promote the participation of girls and young girls in those fields.

Program objectives:

- Showcasing women who are noteworthy for their entry into the world of ICTs (in a successful or novel manner) to share the different study and work opportunities in technology and incentivize girls, boys and young people to try the area.
- Engaging students and teachers in research activities on the participation of women in technology fields, as well as raise awareness on the challenges they face and the benefits of equal participation.
- Creating spaces for reflection based on exchanges in the group of students and between groups of students during the videoconference and the guest speaker.
- Promoting the use of activities in CREA, as well as of other resources offered by Ceibal.

Activities conducted

a) 2019 videoconferences cycle

Conducted: 2019; April/November

Sixty-three applications were received with 39 being confirmed out of which 35 were education centers from 15 departments. We estimate an average of 6.5 participating centers per encounter; 1,050 participating students registered.

Six videoconferences took place together with activities being conducted in the CREA platform.

The guests were:

- Sofia Donner, visual interpreter, illustrator and designer.
- Monica Marin, PhD in Biochemistry, researcher and Dean of the School of Sciences, Universidad de la República (Udelar).
- Alicia Carriquiri, Agronomist, PhD in Statistics and Animal Genetics, Director of the Center for Statistics and Applications in Forensic Evidence in Iowa, United States.
- Sofia Battegazzore, entrepreneur and videogame producer.
- Agustina Sartori, Telematics Engineer and co-founder and manager of GlamST, a Uruguayan platform for virtual makeup.
- Florencia Grattarola, Biologist and researcher. PhD candidate in the area of Ecology and Evolution in Lincoln University, United Kingdom.

b) 2020 videoconferences cycle

Conducted: 2020; August/October

Thirty-four applications were received with 23 being confirmed out of which 21 were education centers from 10 departments. We estimate an average of 8 participating centers per encounter; 312 participating students and 30 participating teachers registered.

Three videoconferences were conducted, each accompanied by activities before and after the session; the guests were:

- Paula Enciso, Biochemist, professor and researcher at the School of Sciences at UdelaR and professor at Universidad Tecnológica.
- Virginia Robano, Economist working in data science and in the implementation of policies for economic development and the labor market.
- Gime "Alaska", content creator for YouTube, presenter for C+ maratón transmedia.

The Ceibal team coordinated the participation of the interviewees and the confirmation of the education centers and led the exchanges. Then, the team was present for the sessions and later responded to inquiries and conducted an assessment.

c) Training activities for teachers

- In the context of the 2020 Summer School, the "Gender and ICT in education: a space for reflection and development" workshop was conducted for teachers interested in the topic; 35 teachers participated.
- A virtual seminar on "Education, gender and ICT: reflections, lessons learned and guidance for action" was conducted with the participation of Anabella Benedetti, researcher for the UNESCO Regional Chair for Women in Science and Technology (Flasco, Argentina.) This seminar was conducted on April 23, 2020, to celebrate the International Girls in ICT Day and launched the Cycle of Videoconferences on Gender and ICT. The seminar was broadcast live through Ceibal's YouTube channel. There were 80 active participants and over 1,500 views after the event.
- The "Gender and ICT in education: Belén Fernández; 1 st encounter" webinar was also conducted for students in teacher training and teachers in general. There were 250 active participants and 170 views after the event. It was conducted live through Ceibal's Instagram account.
- The "Gender and ICT in education: Elisa Cristi; 2 nd encounter" webinar was also conducted for students in teacher training and teachers in general. There were 150 active participants and 156 views after the event. It was conducted live through Ceibal's Instagram account.

d) Progress related to goals

The goals for December 2020 were met:

- nine videoconferences were conducted,
- 1,362 students participated.

Summary and perspectives

Problems

The context of the pandemic and the decisions to adjust the proposal were a priority when considering how to work, as it is believed that the work conducted by the class with the guidance of a teacher in charge is one of the strengths of the proposal. This entailed changing the schedule for dates and number of sessions, and that had an impact on the number of students and teachers involved in comparison to previous editions of the sessions. It should be noted that the average of participating groups per encounter increased. One of the challenges faced was to monitor the response to the videoconference after the event to know how dissemination was amplified.

Opportunities

Given the sanitary emergency and its impact on education, the work schedule was redrafted to onlycover August to October, and the number of sessions was reduced by half. This was done to keep a working methodology by which the group of students can participate together in the videoconference, as this is

believed to favor dynamism and the active participation of groups during the exchange.

Additionally, the time spent working on the platform prior to the exchange was increased to favor the participation of students, considering the alternation between attending centers and hybrid attendance.

Participating centers satisfaction with the proposal
The teachers valued the proposal and highlighted the value and quality of materials available on the CREA platform, as well as the quality of the exchange and the opportunity it gave each student to exchange ideas directly with the speakers at each session.

The high impact and affordability of the proposal is also worth noting.

Additionally, the proposal is assessed positively in terms of the early registration to organize the sessions; this sped up participants confirmation.

Likewise, teachers assessed the time available to prepare their participation in the exchange based on the materials available in the CREA platform positively.

It is worth noting that centers with no videoconference equipment were able to participate through the articulation of the system with the Webex platform.

Another positive note was the integration of the team that developed proposals, a team where collaborative work and contributions from different outlooks and disciplines stood out.

Challenges in 2021

- For the videoconferences cycle:

Promoting, to a larger extent, that the proposal be present in projects developed by the education centers.

Fostering the expansion of the proposal across the territory.

- In terms of the profile of interviewees, and based on results for 2019 and 2020, pay attention to characteristics that may make students feel closer to them.
- Keep the connection to the Webex system to favor the participation of centers with no videoconference equipment, as well as to face contingencies caused by the pandemic, such as to help students or groups that may need to stay home participate. Integrating the gender perspective in technology in the design of the intervention and of supporting materials for the Aprender Todos components (secondary education, teacher training and primary education – community teachers' program.)
- Articulating the topic of gender and ICT to Digital Citizenship.

Training the Project Leaders team on gender perspectives in technology.

Developing a training proposal for teachers focused on gender perspectives in the teaching of STEM.

Keeping a work team that contributes to dealing with the topic more in depth while developing digital citizenship.

Conclusions

The development of the pilot project was positively assessed based on goals reached and results obtained. The context of the pandemic entailed adjusting the schedule and technical aspects, as well as reviewing communication strategies which favored the development of the proposal and resulted in lessons learned to make the most of the activity.

The possibility of including the gender perspective in technology in the design of activities for the Aprender Todos components (secondary education, CFE, PMC) contributed to teacher training, as well as strengthened the inclusion of the topic in the projects of the participating education centers.

At the level of the Project Leaders team, awareness-raising actions on the integration of the gender perspective in technology in education provides tools to carry out actions across the territory.

It is concluded that integrating this line of work is valuable as it strengthens the integration of the gender perspective in the development of digital citizenship and the intervention at the level of components, as well as enriches the training proposal from the program.

Scientists in the classroom

Scientists in the classroom is a program by Ceibal created in 2014 in coordination with the Development Program for Basic Sciences and dealing with different topics in basic sciences through direct contact with Uruguayans researchers. The target audience are groups of students and their teachers, both from primary school and secondary school.

The specific goals of the program are:

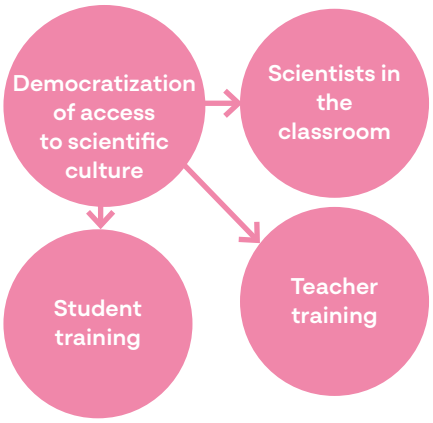
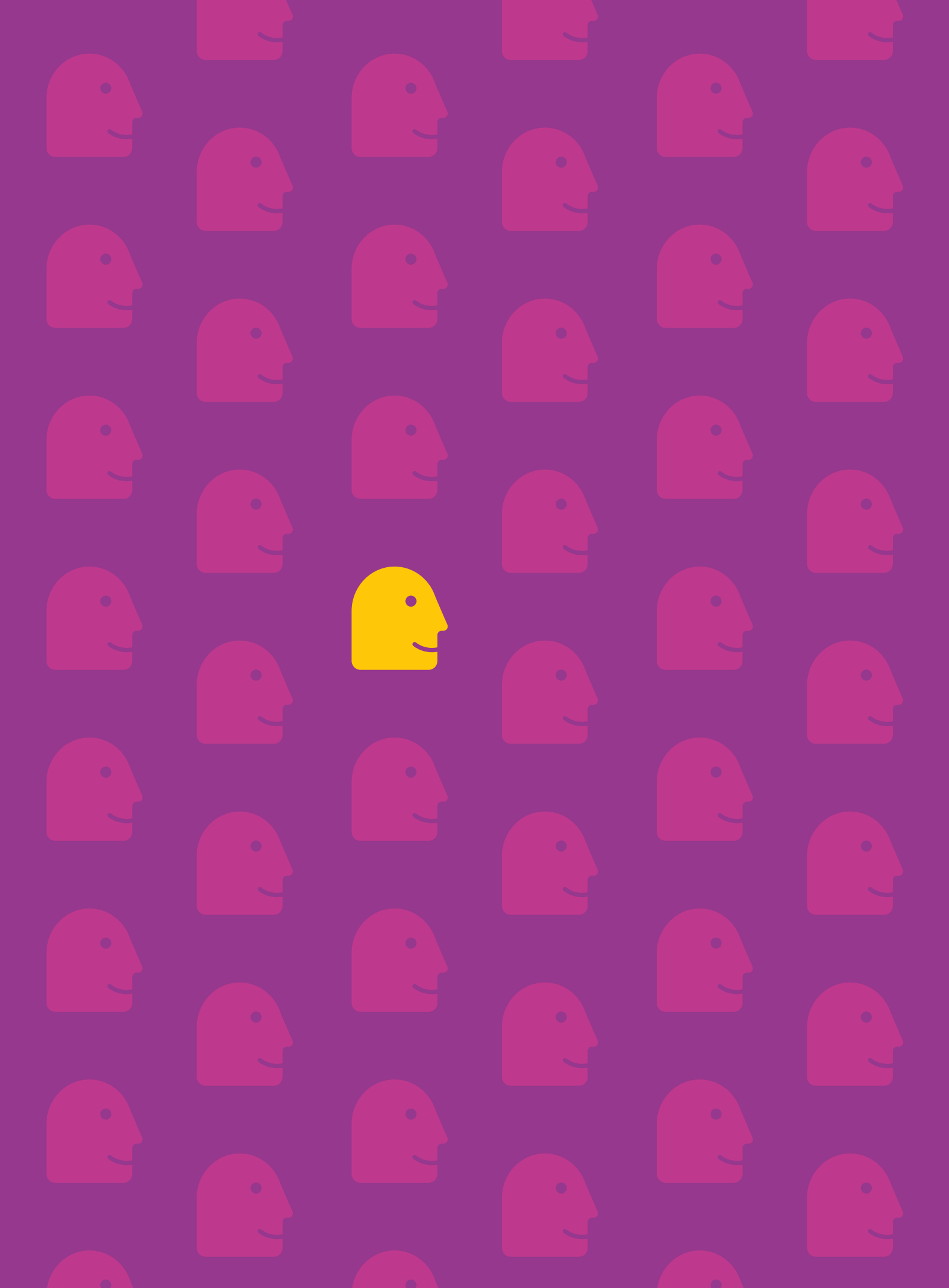


Fig. 2.13: Scientists in the classroom

- Contributing to the education of teachers and students in Uruguay in a specific subject in the area of basic sciences through direct contact with people engaged in research.
- Contributing to teacher training through an innovative education proposal promoting the use of Ceibal's open educational resources and digital mediums.
- Making the access to scientific culture democratic through an educational proposal with a national scope.

The first result of this exercise was the identification of its effects on gender equality in STEM fields since the proposal for Scientist in the Classroom first included the goal to look for gender equality on December 14, 2021.



Part 3

- Results
- Conclusions
- Work team

Results

The third part of this document highlights results, conclusions, tools and recommendations to promote gender equality in Ceibal's STEM ecosystem of Ceibal (figura 3.1).

These lessons learned may be extrapolated to other decision-making arenas to break down barriers and stereotypes preventing girls and women from choosing freely, fostering gender equality in the labor market, promote the financial autonomy of women and stimulate their participation in responsibility and decision-making spaces.

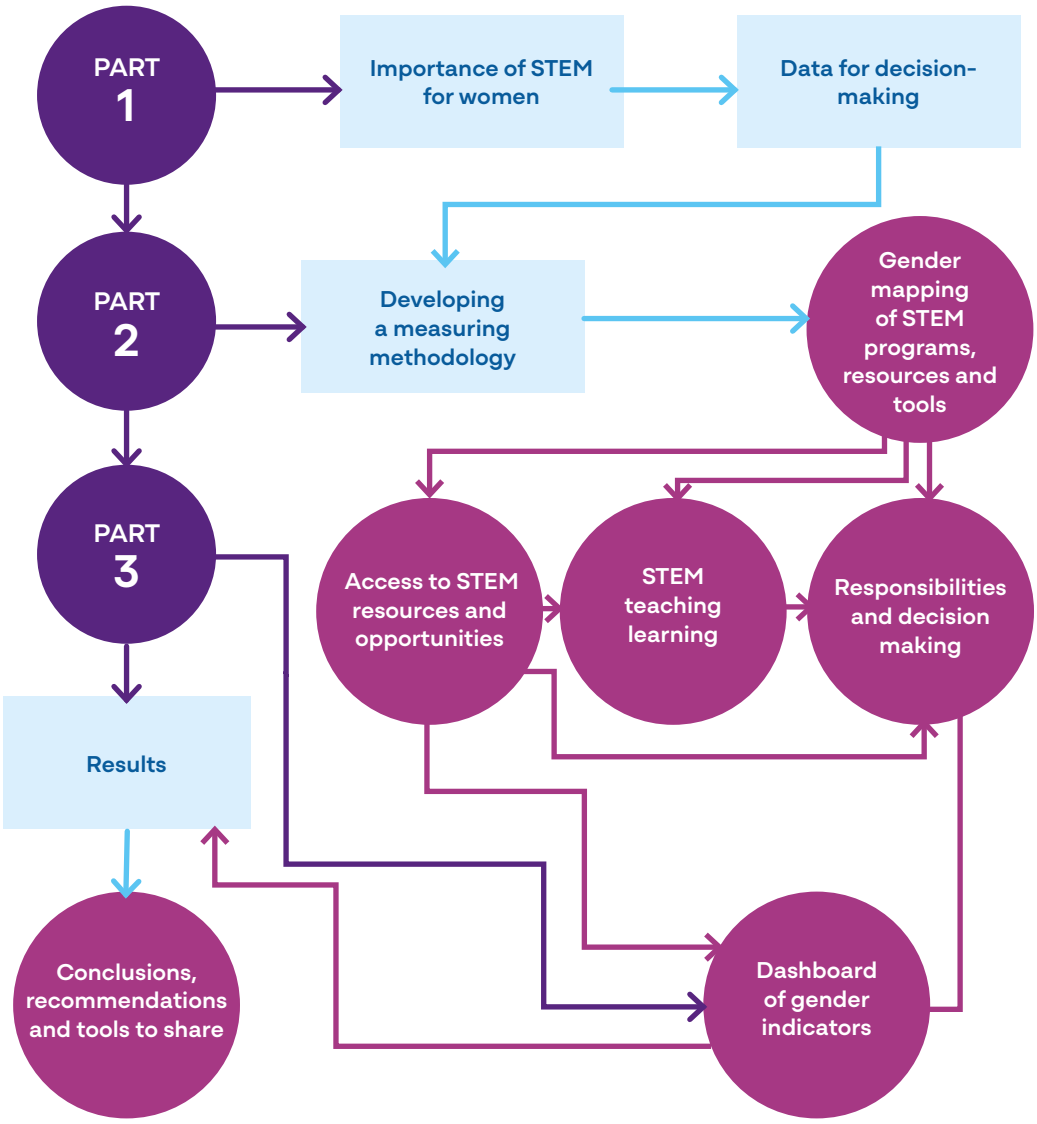


Fig. 3.1: Analysis structure, part III.

This chapter presents the results of this work:

- the dashboard of gender gap indicators in Ceibal's STEM ecosystem;
- the classification of devices, digital tools and STEM programs according to designed framework that allows for establishing connections and chains of effect between the perceptions and stereotypes held by people (students and teachers), the later acquisition of STEM knowledge and the participation in responsibility and decision-making positions.
- the visualization of the gender gap to facilitate data analysis, decision-making and the extraction of guidelines for action to promote gender equality activities in STEM.

Dashboard of indicators

The dashboard of indicators provides aggregated information on each device, digital tool or STEM program only discriminated by the gender of the beneficiary population.

This work measures gender equality in Ceibals STEM ecosystem so that the indicators designed may deal with topics related to gender equality:

- access to resources and opportunities to participate in STEM programs;
- STEM knowledge teaching / learning and
- participation in decision-making roles.

Twelve indicators were designed and measured for the programs, 2 for personal devices and 15 for digital tools.

The green color indicates a gender gap favorable to boys and violet indicates either that there is no gender gap or that it is favorable to girls and women.

Dimension 1 in the chart refers to the “access to STEM resources and opportunities”; dimension 2 refers to “STEM teaching/learning”; dimension 3 refers to “responsibility and decision-making positions.”

Indicators are calculated annually.

Category	Name	Dimension	Indicator	Year	Gender gap	Target pop.
Device	Digital Laboratories	1 y 2	Micro:bit (Delivery)	2018	6.71	students
Device	Digital Laboratories	1 y 2	Micro:bit (Delivery)	2019	6.80	students
Device	Digital Laboratories	1 y 2	Micro:bit (Delivery)	2020	3.04	students
Device	Digital Laboratories	1 y 2	Micro:bit (Delivery)	2021	1.70	students)
Device	Digital Laboratories	1 y 2	Micro:bit (Delivery)	2022	0.62	students
Device	Ceibal	1 y 2	Micro:bit (Delivery)	2018	4.00	teachers
Device	Ceibal	1 y 2	Micro:bit (Delivery)	2019	11.47	teachers
Device	Ceibal	1 y 2	Micro:bit (Delivery)	2020	3.44	teachers
Device	Ceibal	1 y 2	Micro:bit (Delivery)	2021	5.13	teachers
Device	Ceibal	1 y 2	Micro:bit (Delivery)	2022	4.86	teachers
Device	Ceibal	1 y 2	Ceibalitas (primary education)	2007	0.00	students (and teachers)
Device	Ceibal	1 y 2	Ceibalitas (primary education)	2008	0.00	students (and teachers)
Device	Ceibal	1 y 2	Ceibalitas (primary education)	2009	0.00	students (and teachers)
Device	Ceibal	1 y 2	Ceibalitas (primary education)	2010	0.00	students (and teachers)
Device	Ceibal	1 y 2	Ceibalitas (primary education)	2011	0.00	students (and teachers)
Device	Ceibal	1 y 2	Ceibalitas (primary education)	2012	0.00	students (and teachers)

Category	Name	Dimension	Indicator	Year	Gender gap	Target pop.
Device	Ceibal	1 y 2	Ceibalitas (primary education)	2013	0.00	students (and teachers)
Device	Ceibal	1 y 2	Ceibalitas (primary education)	2014	0.00	students (and teachers)
Device	Ceibal	1 y 2	Ceibalitas (primary education)	2015	0.00	students (and teachers)
Device	Ceibal	1 y 2	Ceibalitas (primary education)	2016	0.00	students (and teachers)
Device	Ceibal	1 y 2	Ceibalitas (primary education)	2017	0.00	students (and teachers)
Device	Ceibal	1 y 2	Ceibalitas (primary education)	2018	0.00	students (and teachers)
Device	Ceibal	1 y 2	Ceibalitas (primary education)	2019	0.00	students (and teachers)
Device	Ceibal	1 y 2	Ceibalitas (primary education)	2020	0.00	students (and teachers)
Device	Ceibal	1 y 2	Ceibalitas (primary education)	2021	0.00	students (and teachers)
Device	Ceibal	1 y 2	Ceibalitas (primary education)	2022	0.00	students (and teachers)
Program	Jóvenes a Programar	1	Interest in JaP	2017	3.1	Students
Program	Jóvenes a Programar	1	Interest in JaP	2018	-11.7	Students
Program	Jóvenes a Programar	1	Interest in JaP	2019	-44.5	Students
Program	Jóvenes a Programar	1	Interest in JaP	2020	-8.3	Students
Program	Jóvenes a Programar	1	Interest in JaP	2021	-0.8	Students
Program	Jóvenes a Programar	2	Completed worksheet	2017	5.9	Students

Category	Name	Dimension	Indicator	Year	Gender gap	Target pop.
Program	Jóvenes a Programar	2	Completed worksheet	2018	22.7	Students
Program	Jóvenes a Programar	2	Completed worksheet	2019	-92.1	Students
Program	Jóvenes a Programar	2	Completed worksheet	2018	22.7	Students
Program	Jóvenes a Programar	2	Completed worksheet	2019	-92.1	Students
Program	Jóvenes a Programar	2	Completed worksheet	2020	-0.2	Students
Program	Jóvenes a Programar	2	Completed worksheet	2021	-6.2	Students
Program	Jóvenes a Programar	2	Graduation	2017	39.9	Students
Program	Jóvenes a Programar	2	Graduation	2018	35.1	Students
Program	Jóvenes a Programar	2	Graduation	2019	-100.0	Students
Program	Jóvenes a Programar	2	Graduation	2020	25.6	Students
Program	Jóvenes a Programar	2	Graduation	2021	27.0	Students
Program	Jóvenes a Programar	3	Direct SIL job placement	2018	28.0	Students
Program	Jóvenes a Programar	3	Direct SIL job placement	2019	33.3	Students
Program	Jóvenes a Programar	3	Direct SIL job placement	2020	-1.9	Students
Program	Jóvenes a Programar	3	Direct SIL job placement	2021	18.3	Students
Program	Jóvenes a Programar	3	Direct SIL job placement	2022	10.2	Students

Category	Name	Dimension	Indicator	Year	Gender gap	Target pop.
Program	Computational Thinking	1	participation	2019	0	teachers
Program	Computational Thinking	1	participation	2020	-3	teachers
Program	Computational Thinking	1	participation	2021	-4	teachers
Program	Computational Thinking	1	participation	2022	-7	teachers
Program	Computational Thinking	2	participation	2019	-1	Students
Program	Computational Thinking	2	participation	2020	-1	Students
Program	Computational Thinking	2	participation	2021	-1	Students
Program	Computational Thinking	2	participation	2022	-1	Students
Program	Bebras Challenge	1	participation	2020	0	Students
Program	Bebras Challenge	1	applicants	2021	0	Students
Program	Bebras Challenge	2	median of right answers	2020	-1	Students
Program	Bebras Challenge	2	median of right answers	2021	-5	Students
Program	Robotics, Program Programming and Videogames Olympics	1 y 2	applicants	2016	17.24	Students
Program	Robotics, Program Programming and Videogames Olympics	1 y 2	applicants	2017	34.46	Students

Category	Name	Dimension	Indicador	Year	Gender gap	Target pop.
Program	Robotics, Program Programming and Videogames Olympics	1 y 2	applicants	2018	16.66	Students
Program	Robotics, Program Programming and Videogames Olympics	1 y 2	applicants	2019	15.15	Students
Program	Robotics, Program Programming and Videogames Olympics	1 y 2	applicants	2020	18.70	Students
Program	Robotics, Program Programming and Videogames Olympics	1 y 2	applicants	2021	-23.17	Students
Program	Robotics, Program Programming and Videogames Olympics	1 y 2	applicants	2020	18.21	Students
Program	Robotics, Program Programming and Videogames Olympics	1 y 2	classification	2021	-25.03	Students
Program	Robotics, Program Programming and Videogames Olympics	1 y 2	finalists	2020	13.64	Students
Program	Robotics, Program Programming and Videogames Olympics	1 y 2	finalists	2021	-30.74	Students
Program	Robotics, Program Programming and Videogames Olympics	1 y 2	winners	2020	15.68	Students
Program	Robotics, Program Programming and Videogames Olympics	1 y 2	winners	2021	-54.98	Students

Category	Name	Dimension	Indicador	Year	Gender gap	Target pop.
Tool digital	CREA (Computational Thinking)	learning	comments median	2020	-1	Students
Tool digital	CREA (Computational Thinking)	learning	delivery median	2020	0	Students
Tool digital	CREA (Computational Thinking)	learning	readings median	2020	-1	Students
Tool digital	CREA (Computational Thinking)	learning	comments median	2021	-1	Students
Tool digital	CREA (Computational Thinking)	learning	delivery median	2020	0	Students
Tool digital	CREA (Computational Thinking)	learning	readings median	2020	-3	Students
Tool digital	CREA	opportunities	Number of DGEIP students	2019	3.74	Students
Tool digital	CREA	opportunities	Number of DGEIP students	2020	3.89	Students
Tool digital	CREA	opportunities	Number of DGEIP students	2021	3.77	Students
Tool digital	CREA	opportunities	Number of DGEIP students	2019	-12.06	Students
Tool digital	CREA	opportunities	Number of DGEIP students	2020	-12.20	Students
Tool digital	CREA	opportunities	Number of DGEIP students	2021	-12.59	Students
Tool digital	CREA	opportunities	Number of DGEIP students	2019	17.37	Students
Tool digital	CREA	opportunities	Number of DGEIP students	2020	17.47	Students
Tool digital	CREA	opportunities	Number of DGEIP students	2021	16.31	Students
Tool digital	Ciudadanía Digital	opportunities				course
Program	Mathematics Meeting	learning				course

Category	Name	Dimension	Indicador	Year	Gender gap	Target pop.
Program	Robotics, Programming, and Videogames Olympics	learning				Students
Program	CeiLAB	learning				course
Program	Scientists in the classroom	opportunities				course
Program	Minecraft Education	learning				course
Tool digital	Mathematics platform	learning				Students
Tool digital	Robotics kits	learning				Education center
Device	3D Printers	learning				Education center
Device	Physico-chemical Sensors	learning				Education center
Digital tool	Mathematics	2	Enrollment for teacher training in Mathematics	2018	-32.37	teachers
Digital tool	Mathematics	2	Enrollment for teacher training in Mathematics	2019	-47.64	teachers
Digital tool	Mathematics	2	Enrollment for teacher training in Mathematics	2020	-38.29	teachers
Digital tool	Mathematics	2	Enrollment for teacher training in Mathematics	2021	-44.64	teachers
Digital tool	Mathematics	2	Enrollment for teacher training in Mathematics	2022	-39.07	teachers

The delivery indicator for micro:bit boards presents a gap favorable to boys in all years surveyed. In contrast, the "Ceibalitas" indicator shows there is no gender gap in any of the years mentioned.

To facilitate the visualization of gender gaps, the following site with visualizations was created in addition to this publication: https:// ceibalunidaddatos.sh inya-pps.io/genero-STEM//

Classification of devices, digital tools and STEM programs

This section presents the classification for devices, digital tools and STEM programs based on the theoretical framework developed in this document.

Devices

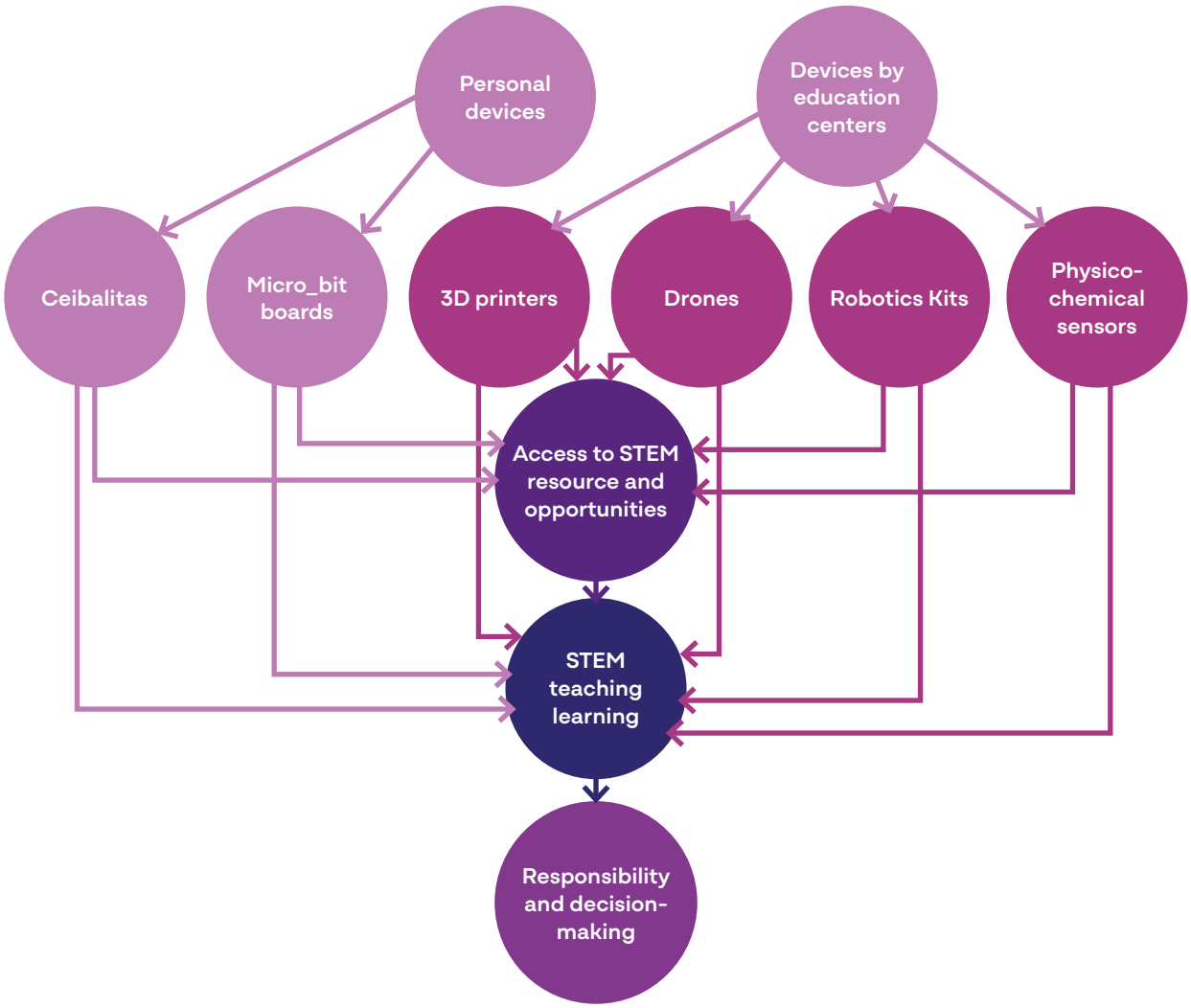


Fig. 3.2: STEM devices of Ceibal

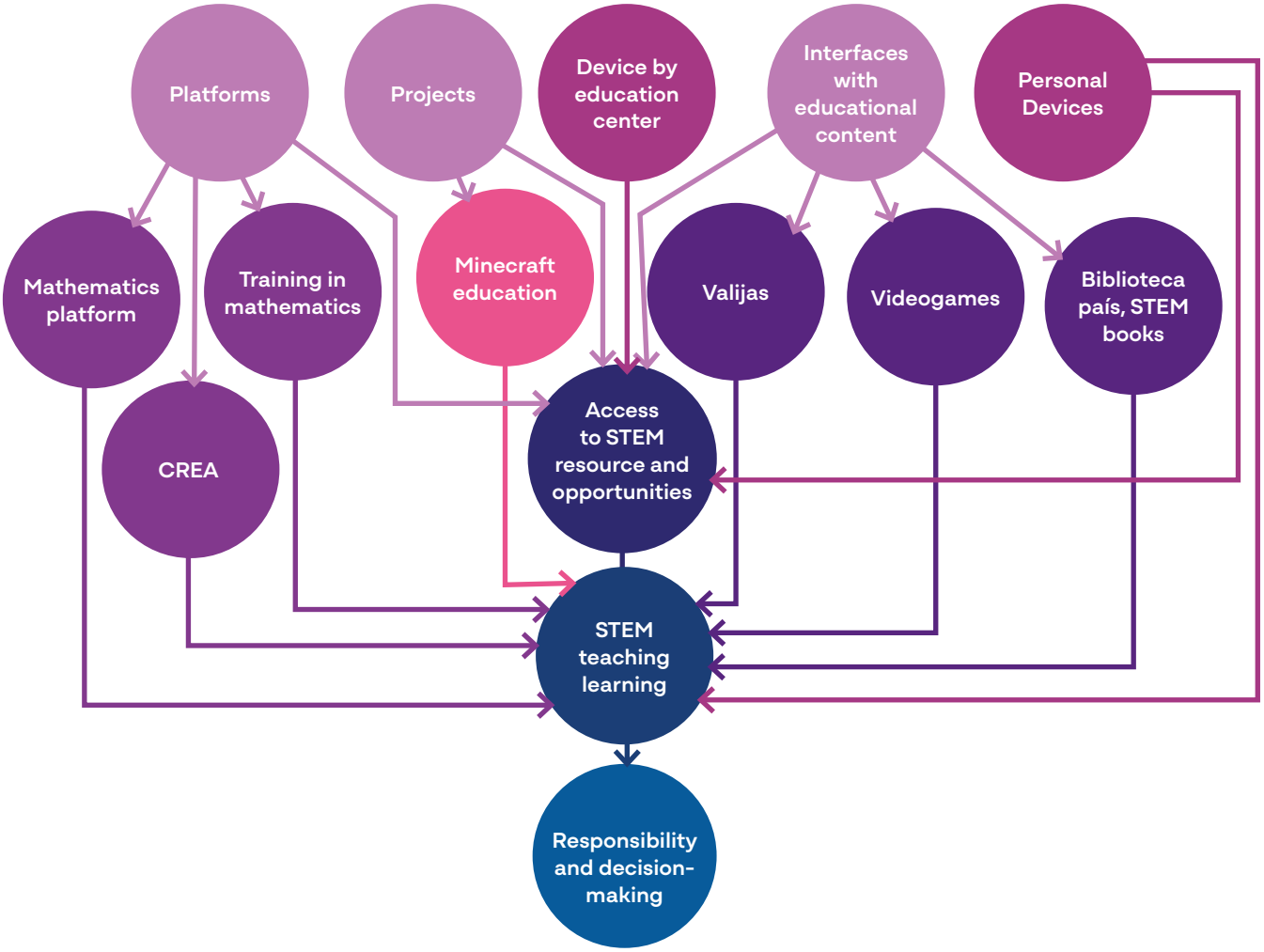


Fig. 3.3: Digital tools of Ceibal

Digital tools

Figure 3.3 maps digital tools in Ceibal. The availability of devices (ceibalitas and micro:bit boards) is essential for the target population (teachers and students) to benefit from the digital tools described here.

Programs

STEM programs in Ceibal analyzed are:

- Mathematics (since 2013);
- Scientists in the classroom (since 2014);
- Digital Laboratories, containing:

  - Robotics, Programming and Videogames Olympics (since 2013),
  - CeiLAB (since 2017),
  - Computational Thinking (primary and secondary school), created in 2017, containing the Bebras Challenge, created in 2020;
- Jóvenes a Programar (2017);
- Science meetings (since 2018);
- Digital Citizenship (since 2018), comprising the Gender and ICT and Digital Safety projects.[1]

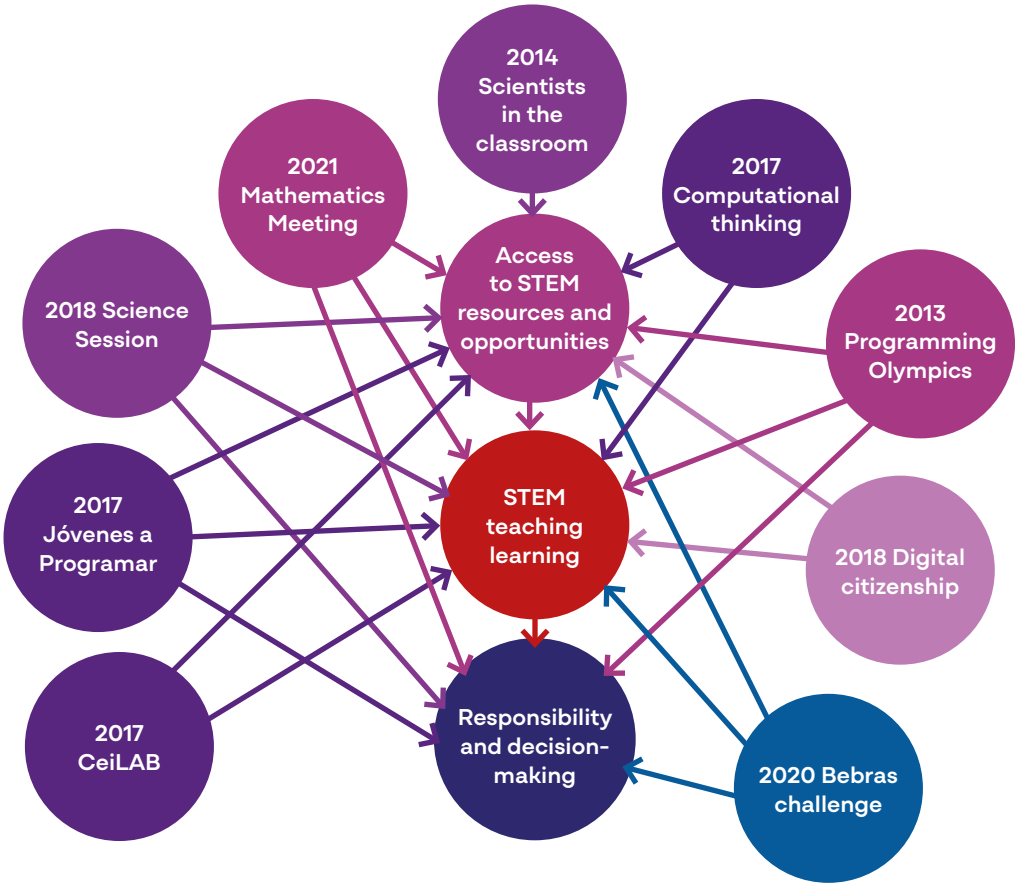


Fig. 3.4: STEM programs in Ceibal

Visualizations

Gender gaps according to the previously described theoretical framework can be visualized in the following link:

It is possible to access images with visualizations on the gender gap through this link: STEM-Ceibal.[2]

[1] The delivery of micro:bit boards depends on Digital Laboratories (since 2018)

[2] https://ceibalunidaddatos.shinyapps.io/genero-STEM/

Conclusions

The third part of this work extracts and highlights results and conclusions. It also shares proposals that may be applied to the design and implementation of STEM programs with gender equality, inside and outside the institution.

For a quick visualization, the green color indicates a gender gap favorable to boys and yellow indicates it is favorable to girls.

Specific conclusions

Ceibalitas are delivered to teachers and students in public primary education. This universal approach prevents gaps in the access to STEM opportunities.

Micro:bit boards are delivered to people who request them (inside the public primary education system.) A gender gap favorable to men is observed for the entire period analyzed.

A possible solution to decrease the gender gaps in this case is to carry out specific actions to increase the demand for micro:bit boards from girls, for example, by organizing games or activities reflecting the interests of girls and teenage girls.

Another option would be to carry out projects by education center using STEM devices (robotics kits, physico-chemical sensors, 3D printers, drones) to encourage more girls and women to join in the activities and, by doing so, increase their participation.

Along the same lines, it is possible to include more female teachers in these projects so they may serve as role models for girls.

A fourth suggestion would be to stimulate the active participation of girls and teenage girls in responsibility and decision-making roles.

Digital tools

CREA
Activities on the CREA platform show a gender gap favorable to girls, both in comments and in visualizations. There is no gender gap in deliverables (activity normally completed upon the request of a teacher in charge.)

Training in mathematics
The teacher training activities show a gender gap favorable to women.[1]

Programas

JaP
The gender gap is favorable to girls and women in the access to STEM resources and opportunities, as well as in teaching and learning processes.

Nevertheless, a STEM gap favorable to men is maintained in the process of job positioning. The ICT area is masculinized. JaP is another stakeholder in the ecosystem, but its potential for action, although important, is also limited.

JaP is a program that bases its decisions on empirical evidence, conducting analyses in real time and using data science to carry out an individualized monitoring of each group, with an **early alert** system that allows for identifying people at risk of dropping out or with low performance.

[1] This indicator, unlike the teaching activities in computational thinking herein presented, was not weighted by the

Computational Thinking

PCT presents gender gaps favorable to girls and women in its indicators of teacher and student participation.

No gender gaps are observed in the participation in the Bebras Challenge, and the **gap in results is favorable to girls**, breaking the stereotype in the perception that boys are better in that area.

Teacher surveys on the perception of skills according to gender show a gap favorable to women in language and soft skills.

Teacher surveys on the perception of skills according to gender show a gap favorable to men in computational thinking and mathematics, **which is not verified with the evidence obtained from those tests, in which girls get better results.**

Programming, Robotics and Videogames Olympics

There is a gender gap favorable to men in the Robotics, Programming and Video Game Olympics enrollment. The "mentions" indicator shows a gender gap favorable to men for the three years for which data is available (2020, 2021 and 2022).

The "winners" indicator shows a gender gap favorable to women in 2021 and to men in 2020 and 2022.

Mathematics Meeting

The program was launched in 2022. There is still no information available to measure the gender gap.

Science Sessions

A gender gap favorable to women is observed in the 2020, 2021 and 2022 Science Journey (Jornadas de Ciencia) enrollments.[2]

[2] This indicator, unlike the teaching activities in computational thinking herein presented, was not weighted by the number

Digital Citizenship

As no information is collected for people, it is not possible to measure the gender gap indicator. The digital citizenship team has assessed its program, including action guidelines for the future.

Some additional proposals for consideration are:

- scontinue showcasing scientist women, so that girls can see them as role models;
- use language to include all people;
- stimulate the participation of girls (it is suggested to follow guidelines for remote teaching in Computational Thinking.).

Scientists in the classroom

As no information is collected for people, it is not possible to measure the gender gap indicator.

The same proposal than those for Digital Citizenship are followed and, additionally, changing the name of the program to **Science in the classroom** is suggested so as to include all people.

General conclusions

CCeibal is an ecosystem working for equal opportunities, which includes the gender dimension.

The Ceibal ecosystem is constantly evolving and includes programs, projects, activities, digital tools and devices that may contribute to having educated, responsible digital citizens.

Out of over 100 indicators surveyed, most do not include a gender gap. If any, they are favorable to women, an important aspect when considering (as was noted at the beginning of the document) that women make up for half the population and their participation in STEM is less than a quarter.

Additionally, the EIGE (2017) suggestion should be noted: **in fields where women are a minority, having policies exclusively geared towards women is an accepted, acceptable policy to achieve gender equality**.

When talking about womens organizations, spaces and specific facilities that may foster their empowerment and social participation, having **only** women participate is a relevant, accepted strategy for the promotion of gender equality, EIGE (2017.)

> Instead of changing the preferences of girls and women towards STEM fields, the aim of this work has been to identify where barriers limiting the presence of women in STEM, including limiting their participation in responsibility and decision-making positions, lie.

Team

This dashboard of indicators is the result of teamwork.

As every structure evolves, the work is not done. It is never done. But it is a beginning, a beginning the team can think about and work together to improve. Let's keep adding ideas!

Fig. 3.5: Team

- Bibliography
- Appendix
- About the author

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Appendix

This section provides a detailed comparison between the EIGE classification categories, starting point for the development of Ceibal's method and action plan.

Detailed comparison between the EIGE and Ceibal classification categories

Some analysis dimensions that EIGE (2017) classifies in the "Division of work by gender" category have been reclassified into three analysis dimensions chosen by Ceibal. EIGE (20147) and Ceibal coincide in classifying the following categories in the **Access to resources and opportunities**:

- social class,
- division of paid and unpaid work,
- ethnicity,
- age.

Nevertheless, while EIGE (2017) classifies the "education" and "horizontal segregation" categories in the "Sexual division of work", this analysis methodology includes these categories in **teaching / learning**, in connection to the control of resources and financial autonomy. Additionally, in the conceptual framework by Ceibal, the **vertical segregation** category is included in **decision making and power** (see Fig. 4).

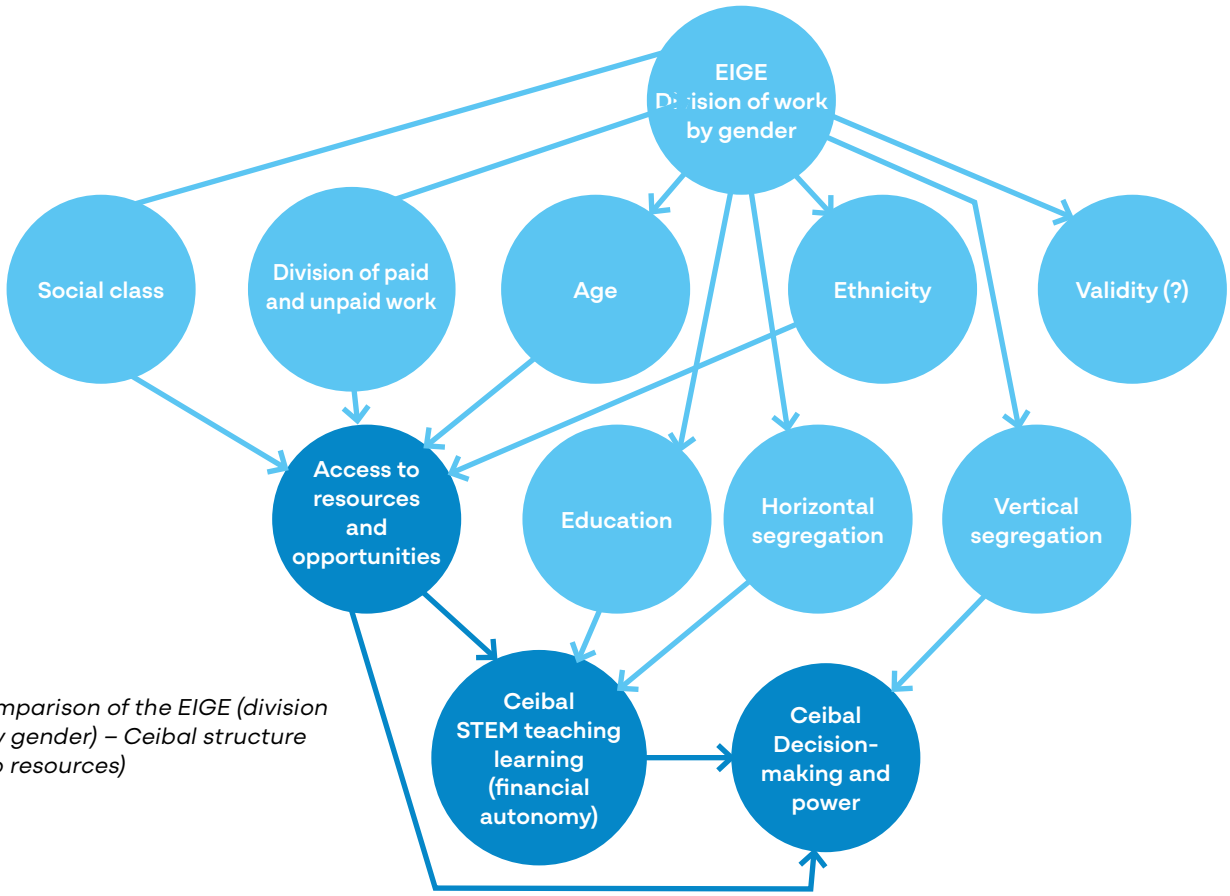

Fig. 4: Comparison of the EIGE (division of work by gender) – Ceibal structure (access to resources)

The activities classified by EIGE (2017) in "Organization of private life" coincide with those classified by Ceibal in "STEM teaching/learning" (resource control, financial autonomy.)

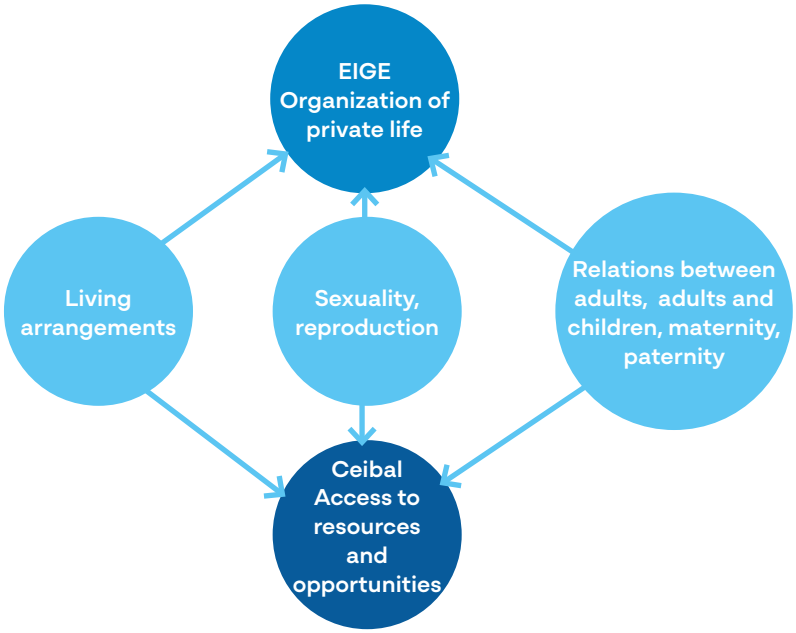

Fig. 4.2: Comparison of EIGE (organization of private life) – Ceibal (STEM teaching / learning) structures

Conversely, not all activities classified by EIGE (2017) in "Organization of citizens" match those classified by Ceibal in "Decisions and power": the opportunity to participate in society and the effect of the press are included in "Access to

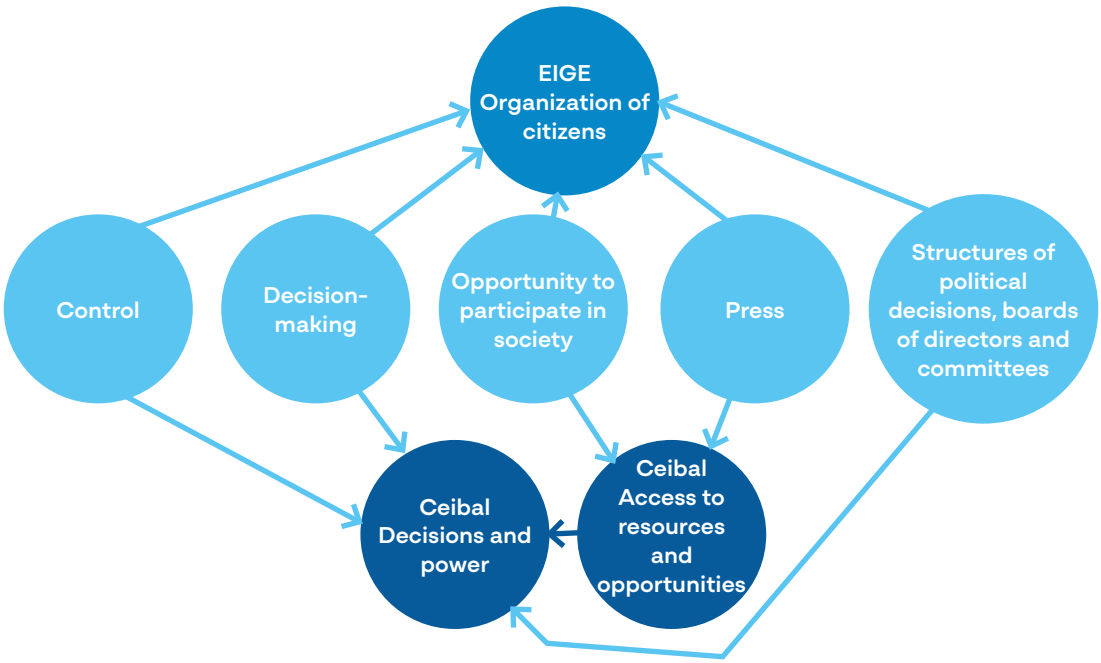

Fig. 4.3: Comparison of EIGE (organization citizens) – Ceibal (decision-making and power) structures.

resources" in the classification by Ceibal.

When talking about organizations, spaces or facilities specific to women to foster their empowerment and social participation, having only women participate is a relevant, accepted strategy to promote gender equality (EIGE, 2017.).

In addition to EIGE, there are other classifications made by international organizations to foster gender equality. For example, the UN identifies five domains (detailed below.) That classification was not considered in this study, since the cross-cutting grouping of dimensions does not allow for identifying concrete actions and instruments for each policy or course of action to be implemented, something which the Ceibal methodology does allow for.

Other UN classifications with a gender equality approach:

Domain I, Economic structures, participation in productive activities and access to resources, covers the use of time, statistics on the workforce and data on the use of technology and media.

Domains II, Education, and III, Health and related services, cover statistics in education and health, while Domain IV, Public life and decision-making covers statistics on the participation of women in multiple decision-making positions.

Additionally, Domain V, Human rights of women and girls covers early marriage and domestic violence and other forms of violence against women and girls.

Example of actions to promote women in STEM

The figure highlights multiple elements of proposals in Latin America to foster gender equality in STEM (UN Women, 2020)..

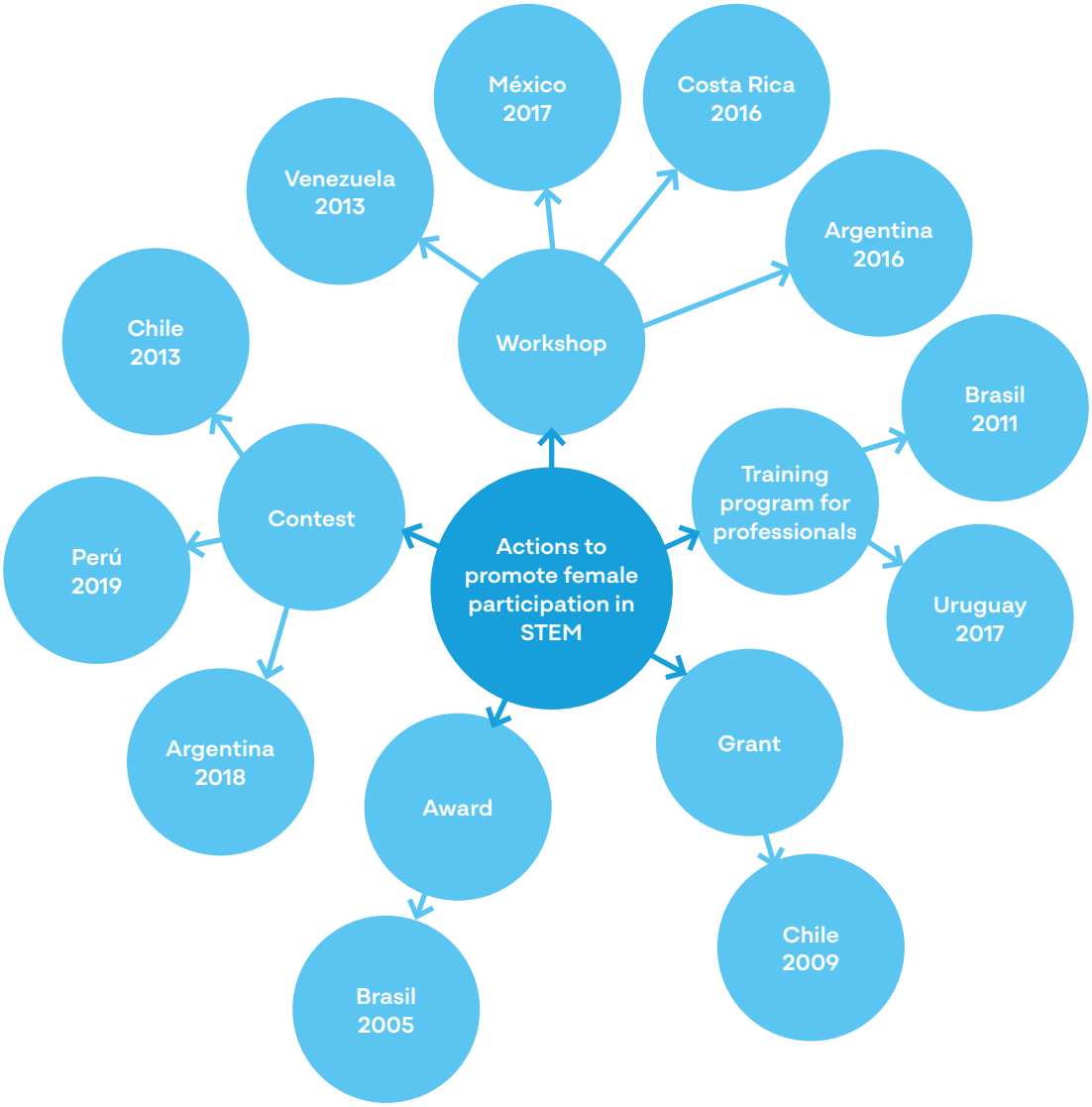

Fig. 4.4: Example of proposals in Latin America for gender equality in STEM (UN Women).

About the author

Virginia Robano holds a BA in Economy (Universidad de la República) and a PhD in Economy specialized in economic development and labor markets from George Washington University in the United States. She analyzes and researches topics on gender in labor markets. In 2018-2020, she launched and directed the first professional master's degree in Data Science in Uruguay. She is focused on bringing down barriers and stereotypes limiting opportunities for people; seeks to promote the financial autonomy of women and foster citizen participation, occupying decision-making positions with responsibility and commitment. Since 2020, she is an ambassador for the WiDS Montevideo (Women in Data Science), organized by Stanford University, and has held three conferences in Montevideo.

In 2013, she won the first prize in a global competition organized by the Global Development Network, which gathered over 700 presentations. Her research work "The enigma of the wage premium for part- time work: an assessment of the Chilean case" won the Research and Social Development/Production Medal. She received the award in Manila, the Philippines.

Virgina has ample international experience: sha has worked and lived in the United States (she worked in the World Bank and the Inter-American Development Bank), Argentina (Universidad Torcuato Di Tella, regional office for the World Bank) and Uruguay (Central Bank of Uruguay, Ceibal.).