

Towards Gender Equality: Girls' Day at the Museum of Astronomy and Related Sciences

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It is widely recognised that women are underrepresented in science, technology, engineering and mathematics (STEM). The United Nations Educational, Scientific and Cultural Organisation (UNESCO) is encouraging worldwide efforts to overcome gender disparities, and the Girls' Day at the Museum of Astronomy and Related Sciences (MAST) in Rio de Janeiro, Brazil, is one such initiative. The event stimulates discussion on inequality in science, brings female scientists and young people together and inspires young women to pursue astronomy through communication and engagement activities.

Introduction

Science is a powerful institution for the development of humankind, but as with any other human endeavour, it is not neutral but subject to the social constraints and norms that exist in society at the time and place it is developed. Several social studies of science have concluded that science is value laden (Bronowski, 1956). The underrepresentation of women in science, technology, engineering and mathematics (STEM) careers is part of the social context of science and how it has developed.

Gender segregation in this context refers to the unequal distribution of men and women in careers and may occur in two forms: (1) horizontal segregation or gender tracking, meaning that men and women cluster in different jobs and (2) vertical segregation or a glass ceiling, meaning that men occupy the top-tier jobs whereas women are concentrated in the less powerful, prestigious and lowest-grossing positions in the workforce.

As with other sciences, astronomy is subject to this gender imbalance. Many factors have been cited as potential contributors to this and affect female professionals in the field (Flaherty, 2018; Reid, 2014). Strategies to address these issues include the inclusion of more young women in dis-

cussions about STEM careers. Girls' Day at the Museum of Astronomy and Related Sciences (MAST) is oriented towards this and attempts to tackle the horizontal segregation problem in STEM careers.

A recent study showed that Brazil is a global leader in terms of the participation of women in the sciences (Elsevier, 2017), with nearly half of the country's scientific scholarly articles written by female authors. This is an important step towards equity, but stratification across research fields shows that Brazilian female scientists are predominantly clustered in the fields of social science, education, biology and medical sciences. The percentage of Brazilian women in physics, geology, engineering, computer sciences and astronomy careers is far lower.

Data from the Brazilian National Council for Scientific and Technological Development Census indicate that the percentage of PhDs in STEM subjects held by women is 31%¹. A study by the International Astronomy Union (IAU) (Cesarsky & Walker, 2010) that analysed the percentage of women from countries with at least 40 IAU members, as is the case with Brazil, indicates that the increase in the number of women in astronomy-related careers has been negligible over the years. In 2009, when the study was carried out, the per-

centage of Brazilian IAU members who are female was 22.7%. Twelve years previously, this percentage was 16.5%. Using IAU membership as an indicator and assuming the improvement continues at this rate, Brazil will not reach gender equality in astronomy until 2070. To increase this rate, more girls need to opt for studying STEM subjects.

Another motivation for selecting girls as the target group for the engagement activity described in this paper was the results of a 2015 survey on public perception of science in Brazil². The results of this survey showed that only 6.7% of the population can name a Brazilian scientist, and this percentage dropped to 2.7% among girls aged 16–24 years.

Girls' Day around the World

Initiatives aimed specifically at engaging girls with science and encouraging them to pursue STEM careers have been adopted since at least the early 90s. In the US, girls would accompany relatives working in STEM to work at certain participating companies, scientific institutions and universities. Girls' Day grew out of this movement and was first adopted across Europe in the early 90s.

Since its implementation in 2001, the Girls' Day-Mädchen-Zukunftstag in Germany, has reached over 1.7 million girls and adolescents. It has been officially implemented by the Federal Ministry of Education and Research, the German Trade Union Confederation and the D21 initiative, and coordinated by the Competence Centre for Technology, Diversity and Equal Opportunities. The number of participants increases every year, and data show that 33% of the participating institutions have later received traineeship requests from young women who had attended the Girls' Day events. A marginal increase has also been found in the number of young women pursuing STEM careers at German universities (in 2008, 21% of STEM students were female; in 2018, this value was 24.9%). More information on these results is available on the programme website³.

In Hungary, the Girls' Day initiative took place for the first time in 2012, and now involves nearly 2000 students per year (Vámos, 2012). In Portugal, the Museu das Comunicações first celebrated Girls' Day in 2017 by launching a competition for digital art works⁴.

The Girls' Day model has also taken place in the Science Museum of Minnesota, Burke Museum, Museum of Science in Boston, Nemo Museum in Amsterdam and Deutsches Museum in Munich, among others. These programmes range from single-day events to long-term programmes with activities that aim to stimulate interest in science among girls. Some museums, for example, Deutsches Museum, provide guided tours that highlight areas led by women in their exhibitions⁵.

Role of Museums in Gender Equity

The described initiatives are best understood in light of the intense democratisation happening in museums worldwide. Museums have become more than mere preservation and exhibition establishments, expanding their field of action to embrace new practices and activities (Valente, 2009). They have developed broad educational programmes aimed at increasing dialogue with the public, who are increasingly seen as active participants rather than passive receivers of information (Marandino, 2008).

Marandino (2008) highlights that visiting a museum may not only stimulate a will for learning and observation but bolster the exercise of responsible citizenship through educational activities and encourage the participation of diverse groups of people from different socio-economic backgrounds. This is of utmost importance, since recent studies show that despite recent changes, science museums still pose multiple barriers for lower-income and minority groups (Dawson, 2014).

The researchers at the Science Education Department at MAST have long been aware of the potential that science museums have to promote social change and empowerment (Cazelli et al., 2018). This is particularly interesting for gender inclusion, as the museum becomes a place to question the privileged production of scientific knowledge by the male half of the population.

It can also be an arena through which role models can be provided to young female visitors. The researchers believe that museums need to grow into social institutions dealing with issues of public interest, as well as creating spaces for traditionally excluded audiences. They need to act as agents of inclusion (Gruzman and Siqueira, 2007).

Girls' Day in Brazil

Motivated by events taking place around the world, and a will to contribute to social inclusion and gender equity in science, Girls' Day at MAST began in 2015. It was promoted in March to coincide with International Women's Day. Designed to inspire a potential generation of researchers, the event connected girls with prominent female scientists from various sci-



Figure 1. Promotional flyer from the third edition of Girls' Day in Brazil. Credit: MAST, Rio de Janeiro.

	2015	2016	2017	2018
Theme	Women in science: Experiences and perspectives	Girls in STEM: Yes we can!	First-timer Scientists	Science is for all: gender and ethnicity matter
Research fields and areas of invited speakers	<ol style="list-style-type: none"> 1. Astrophysicist, Maximilians Universität Munich, Germany 2. Historian of Science, PUC-Rio de Janeiro, Brazil 3. Non-formal education researcher, Universidade Estadual de Campinas, Brazil 4. Physicist, Université Paul Cézanne, France 	<ol style="list-style-type: none"> 1. Astrophysicist, Technical University Munich, Germany 2. Physicist, University of Manchester, UK 3. Mobility Engineering, responsible for the traffic operations of the 2016 Summer Olympics 4. Pharmacist, Universidade de São Paulo, Brazil 	<ol style="list-style-type: none"> 1. Nuclear Engineering (winner of the international competition Nuclear Olympiad) 2. Pharmacist and innovation analyst 3. Student of Chemical engineering, member of the NASA Rover Challenge 2017 4. Student of physics 	<ol style="list-style-type: none"> 1. Astrophysicist, Caltech USA 2. Pharmacist 3. Physicist with experience in science museum theatre 4. Chemist with experience in Afro-textured hair 5. Geologist 6. Computer scientist, Apple Developer Academy
Education activities	<ol style="list-style-type: none"> 1. Observation of the Sun with telescopes 2. Guided museum tour 	<ol style="list-style-type: none"> 1. Hands-on activities about nebulas and the interstellar medium 2. Telescope assembling and pointing 3. Theatre piece on the life of a scientist 	<ol style="list-style-type: none"> 1. Talk about female scientists forgotten by history 2. Electronic circuits workshop 3. Chat with the female competitors in the NASA Rover Challenge 2017 4. Dramatised guided museum tour 	<ol style="list-style-type: none"> 1. Hands-on activity about Mary Sharp and plate tectonics 2. Hands-on activity: Scale model of the Solar System 3. Guided museum tour 4. Observation of the Sun
Audience – Total number	122	134	170	152
Round-table on-line viewers	266	164	265	382

Table 1. Themes, activities and audience of previous Girls' Days at MAST.

entific institutions and universities in Rio de Janeiro, Brazil, as well as providing them with an opportunity to experience hands-on activities associated with astronomy and related sciences. To our knowledge, it was the first initiative of this kind in Brazil.

The first Girls' Day at MAST received 35% more participants than originally planned. Given this expression of interest, the event was officially included in MAST's annual agenda. In 2019, in its fifth year, Girls' Day at MAST will also be part of the IAU100-Under One Sky agenda.

The goals of Girls' Day at MAST are (1) to encourage girls to explore scientific career paths; (2) to acknowledge the contribution of female scientists and STEM professionals to scientific progress and society at large and to celebrate this with the general public; and (3) to break down social barriers and prejudices that prevent girls from pursuing STEM careers.

In all the editions of Girls' Day at MAST, we start with a round table meeting with researchers and professionals involved in

science, technology and innovation. This debate is followed by a coffee break and observations of the Sun, to give the participants time to interact with the invited speakers in a relaxed atmosphere. After this, science education activities take place in small groups. The audience members can choose which activity they want to participate in beforehand. At the beginning of the event, the participants are provided a brief perspective of why gender equity in science matters. The discussion at the round table is streamed live. Table 1 summarises the activities that have taken place so far and the total number of people involved.

The first and second editions of Girls' Day at MAST focused on showcasing prestigious female STEM researchers and professionals and their contributions to the public. The invited scientists shared their personal experiences and the path they took towards a successful career in STEM.

A few months after the second Girls' Day, the coordinators of the event decided to go one step further. They launched a long-term science education pilot programme

oriented toward female high school students. The programme had the goal of preparing the participants to act as science museum mediators⁶, providing them not only the opportunity to learn astronomy through workshops but also to act as role models to younger visitors. To achieve this goal, three distinct phases were defined for the programme. In its first phase (July to December 2016), the participating students were trained to act as mediators during the third edition of Girls' Day at MAST. They also followed theoretical lectures and practical workshops on astronomy, science education and mediation in museums, as well as gender in science. In the second phase (February to September 2017), participants worked on the development of experiments and education activities. They also regularly acted as mediators in the education programme of the museum. The third phase of the project took place in October 2017, when the participants exhibited their experiments during the Science and Technology National Week. The results of the evaluation of the long-term project for girls are presented in Benítez-Herrera et al. (2019).



Figure 2. A dramatised guided tour through the Museum of Astronomy, former home of the National Observatory in Brazil, from the third edition of Girls' Day Brazil. Credit: MAST, Rio de Janeiro.

The first experience of the participants acting as mediators was during the third Girls' Day at MAST. We shifted the event focus from presenting renowned scientists to scientists in training, discussing the importance of exposing girls to science at a very young age. All of the invited speakers at the round-table discussion were young professionals or college students who got involved in science when they were still adolescents. The girls participating in the long-term programme at the museum led the hands-on activities that followed the round-table discussion, always accompanied by a senior scientist. This proved to be a good way to introduce junior scientists or scientists in training as role models to the girls who participated.

In the fourth edition, a wider discussion was launched. As a developing country, Brazil faces serious racism issues. The socio-economic status of the population strongly correlates with skin colour. Therefore, it is careless to discuss gender segregation and skip the segregation that Afro-Brazilians and indigenous groups face. If the presence of women in STEM careers is not adequate, the presence of black and indigenous women is almost negligible¹. With this in mind, the Fourth Girls' Day saw multi-ethnic scientists speaking to the girls. In this edition,

we held more than one round-table discussion to accommodate different topics. We also invited speakers who are currently studying topics that are of interest to black communities, such as environmental racism and properties of Afro-texture hair. Unfortunately, we found only one indigenous female scientist based in Rio de Janeiro, and even she could not accept our invitation to speak because she was doing field work in the Amazon.

The target audience of all events were teenage girls, but we have not restricted attendance to any age, or even gender. We did, however, always have a high school class (boys and girls) invited to take part. This comprised 40% of our capacity, and the remainder of vacancies were offered on a subscription basis. Nonetheless, we received spontaneous visitors who had not subscribed to the event, and we always tried to accommodate them. Interestingly, other groups of participants also showed up, namely, families with elementary school-aged children (parents brought their daughters and even their sons), groups of friends (female youngsters accompanied by male friends), activists or researchers interested in learning the pedagogical practice of the event and female university college and graduate students. In the third edition of the event, a considerable number of younger girls (6–10 years old) attended accompanied by their parents or guardians. In the fourth edition, we had a larger percentage of black teenage girls, a population usually underrepresented in science museums.

Conclusions

Gender imbalance in science is a problem that affects society as a whole. Attracting more women to science and, consequently, to astronomy is not only a matter of fairness, but a question of welcoming 50% of the intellectual capacity of humankind.



Figure 3. A great crowd of girls filled the auditorium to hear the invited speakers. Credit: MAST, Rio de Janeiro.

As institutions, science museums have the mission of expanding society's access to scientific knowledge and encouraging the excitement of discovery. They cannot be places that legitimise the exclusion of women's important contributions to science. Further, science museums must also engage diverse audiences and address the many facets of inclusion, without losing evidence of how our culture and knowledge have evolved to date. Therefore, it is fundamental to reflect on these issues and adapt the content of exhibits and activities to be gender inclusive.

Notes

- ¹ The Brazilian National Council for Scientific and Technological Development Census: <http://lattes.cnpq.br/web/dgp/censo-atual/>
- ² Public attitudes to science survey results: <http://percepcaocti.cgee.org.br/>
- ³ Girls' Day - Mädchen-Zukunftstag Analysis Webpage: <https://www.girls-day.de/Daten-Fakten/Zahlen-Fakten/Evaluation-und-Statistiken/Girls-Day-Evaluation>
- ⁴ International Girls in ICT Day (2017) activities in Europe: <https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Publications/International%20Girls%20in%20ICT%20Day%202017final.pdf>
- ⁵ Deutsches Museum Special Guided Tours: <https://www.deutsches-museum.de/en/whats-on/guided-tours/special-guided-tours/>
- ⁶ Mediators are the professionals responsible for welcoming the public and carrying out activities in museums, such as guided tours and practical activities. They allow the visitors to deepen their understanding of the themes presented and make their experience more significant. Other terms used to describe these individuals are educators, monitors, presenters, guides and explainers.

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Biographies

Patrícia Figueiró Spinelli and Sandra Benítez Herrera have PhDs in Astrophysics from the International Max Planck Research School of Astrophysics, Germany. Currently, Patricia is a researcher in the area of science education at the MAST, and Sandra is a public astronomer at the Institute of Astrophysics of the Canary Islands.

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