Theatre, labs and gender: an education package to improve STEM working environment

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Abstract.

Gender affects all aspects of life, and the working and learning environment of science, technology, engineering and geosciences presents no exception. Gender issues concerning access, permanence and ascension of women in exact and earth sciences careers in general relates between other causes, to the underrepresentation of women in science communications, sexual or moral harassment caused by professors and colleagues during undergraduate and graduate ages, or the overload of housework for girls, when compared to boys, during early school ages. In other words, gender imbalance in science and technology careers may be seen as the result of a series of structured oppressions suffered by women of all ages. In this context, we propose the development of an education package designed to understand these processes at different levels. One of the tools of this package is known as the Theatre of the Oppressed. Elaborated by Augusto Boal in the 1970s, the Theatre of the Oppressed uses theatre techniques as means of promoting social and political changes. Usually, a scene takes place, revealing an oppression situation. The audience becomes what is called "spect-actors", where they become active by exploring, showing, and transforming the reality in which they are living. In the context of gender issues in exact sciences careers, the students can stage situations that reveal subtle actions of power relations that usually put women in subservience places. Our experience showed that even though the acting is fiction, the spectators learn much from the enactment, because the simulation of real-life situations, problems, and solutions stimulates the practice of resistance to oppression in reality, within a condition that offers a "safe space" for practicing making a change. The package also includes a set of laboratory routines based on the work of female scientists, directed to students from 12 to 18 years old. The idea of the labs is to work as a school reinforcement on natural sciences disciplines, and to give visibility to women in science, improving issues such as underrepresentation and mistrust in women work. We show the evaluation of learning efficiency by assessing the results of a quiz.

1 Introduction

Gender gap is measured globally by the World's Economic Forum in four key areas: economic participation and opportunity, educational attainment, health and survival, and political empowerment (Forum, 2020). According to the 2020 Global Gender Gap index (Black, 2020), it will take us nearly 100 years to achieve gender parity. Today, 55% of working-age women are in labour market, against 78% of men. This gap is being narrowed in the last decades, and having more women exerting economic activities outside the home usually translates into better improved health, reduced domestic violence for girls and women, and a greater economic growth for the society as a whole. But according to the World's Economic Forum report (Forum, 2020), if we consider the fastest growing professions of the future, a critical data reveals a problematic situation: women form only 26% among people with artificial intelligence and data skills, 15% among people with engineering skills and 12% among those with cloud computing skills. The inclusion of young girls in Science, Technology, Engineering and Mathematics (STEM) courses is thus an important key to embed gender parity, and to prevent a setback against women's access to labor market rates.

The underrepresentation of girls and women in STEM fields is a complex (Reinking and Martin, 2018) and worldwide phenomenon (Stoet and Geary, 2018). The subject is treated into vertical and horizontal aspects, where vertical refers to advancement steps in career, while horizontal aspects represent societal structural constructions. Vertical seggregation are usually represented by some metaphors, such as the *leaky pipeline* (Lima, 2013; Grogan, 2019), that depicts women passively leaking out of STEM careers, revealing a waste of feminine potential and public resources. Another famous metaphore is the *scissors diagram* (Neugebauer, 2006), which is a plot of the percentage of men and women holding pre-doctoral, post-doctoral, junior group leader, and professor positions, that in most countries shows a steady decline for women as career stages advance, while the corresponding curve for men arises. The intersection between the lines generates a figure similar to a scissor, which refers to the effect of women being "scissored out" of STEM carrees. Finally, the *glass ceiling* (Rosser, 2004; Amon, 2017) or *crystal maze* (Lima, 2013) methaphore refers to the specific obstacles faced by women along their career paths. Lima (2013) argues that the image of the maze marks diversity and multiple barriers along the female trajectory, and the crystal transparency refers us to the obstacles faced by these women, that at least in Brazil, are not formal, but exist.

In a broad sense, gender issues in STEM form a diverse topic, including barriers faced by transexuals, or homophobic environments (Patridge et al., 2014; Duncombe, 2019). In this work, we focus on women challenges and its intersections with race and class oppressions, and we show the results of an arts-based strategy to discuss gender issues in STEM.

The literature on the causalities of the STEM gender gap is today large and growing. Well-known issues that constrain women participation in science, such as housekeeping and motherhood, are largely documented, but Abouzahr et al. (2017) showed that having children does not make women less ambitious for carreer achievements. Instead, they demonstrated that women start their careers with as much ambition as men—or more, but an ambition gap occurs when women work in companies where employees of both genders report low progress on diversity values. More and more research reveals that the subtle ways of privileging a certain body in devaluation of another make up an important structure of the gender imbalance scenario. Chilly climates in some departments and institutions are frequently reported (Holmes, 2008). Women are also less likely to receive prizes and awards, and are less invited to conference talks (Holmes et al., 2011; Ford et al., 2019). In addition, King et al. (2018)

55 have shown that women and other minorities often experience a feeling of not belonging when attending scientific conferences, due to the accumulation of largely subtle behaviour and interactions during their talks, and to a stablished behaviour code that often privilege white researchers and men. In the geosciences, fieldwork culture usually extols masculine strength and resistance (Carey et al., 2016), and it is not uncommon the lack of infrastructure for women on ships or proper accommodation in field trips (Holmes, 2008), which promotes a feeling of lack or not welcoming.

60 While some works show that there are no gender differences between girls and boys skills in math (Kersey et al., 2018), it is widely investigated that girls and women are more concerned than boys with their teachers, parents and mentors evaluation (Aiken and Dreger, 1957; Dickhäuser and Meyer, 2006; Ginther and Kahn, 2015). In short, it seems settled that subtle issues and structured behaviours matters concerning gender gaps in STEM field. On the other hand, it is not straightforward dealing with emotional aspects, such as low self esteem or point out a particular behaviour. According to Renki (2018), communicating

65 someone that they are being sexists or racists usually doesn't work . Besides, there are multiple ways to stereotype different social groups, and tracing how someone is treated based on particular characteristics is a tricky task.

The present study describes a method designed to promote a positive environment towards diversity in the various contexts that permeate the University, including its access and permanence of graduation and undergraduation students, the gender biased relations between professors, students and technicians, and the superior management policies. We developed an arts-

70 based mobilization tool to overcome self expression barriers, focused on a highly diverse public, including high school students from public schools, natural sciences students from the University of Brasilia, professors and researchers. We perceived that the tool has the capacity of reaching the attention of the university top management on gender issues within all the discussed sectors. The goals of this article, then, are to describe one method of:

1. communicating about university access among different groups (race, class and gender)

75 2. bringing gender issues discussions into the university community (faculty, staff and students) avoiding direct conflicts

3. publicize the work of female scientists

4. provide a safe place to promote discussions and to empower female students

This work has practical implications for companies, schools and universities managers and research coordinators, by describing a project that aims to foster gender parity by promoting self understanding, revealing social structures and unveiling

80 myths.

2 Background

2.1 Structural gender issues in STEM carreers

The academic and pedagogical scenario related STEM fields still present asymmetries when observing gender issues. Science represents a field of disputes, in which different axes of subordination intertwine (Minella, 2013) . The experiences of subjects

85 termed as women are distinct when compared to men. The studies that bring the theme gender and science in Brazil, begins in the mid-70, with the second feminist wave. The relevance attributed to this theme was made remarkable in 1990, with evidence of the absence of women throughout the history of science in the country (de Melo and Oliveira, 2006). Currently the research and actions related to gender and STEM have the collaboration of different institutions (academia, government, NGOs, spaces of formal education) to problematize, analyze and propose actions that can restructure and assign new meanings to science.

90 To better understand the existing asymmetries within scientific contexts related to gender, this section describes the academic and educational scenario in the following order: distinctions between taste and learning throughout basic education; insertion of women in science courses; persistence in academia; professional advancement of men and women. After characterizing this analysis, the question follows: what still interferes with the distinctions between men and women? Finally, in a simplistic way, highlight the possible ways in front of the described scenario.

95 The worldwide scenario analyzed by the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2017) highlights significant advance in girls' participation in education, bringing emphasis to higher education. In assessing the presence and permanence of girls in basic education, despite increased access in many contexts, socioeconomic and cultural barriers still make it difficult or impossible for students to complete and benefit fully from the good educational quality of their choice. During primary education, when children are already exposed to science and math content, gender role stereotypes

100 are already present Leslie et al. (2015); Dickhäuser and Meyer (2006). Teachers report that, in evaluations, they have different expectations regarding learning in science and math for girls and boys (Dickhäuser and Meyer, 2006). The boundaries imposed by stereotypes are widened during adolescence, when gender roles become more entrenched for girls, including domestic and care responsibilities, the possibility of early marriage and pregnancy, and cultural norms that prioritize boys' education. These boundaries implies in higher rates of girls losing interest in STEM subjects with age (UNESCO, 2017; Sylvia et al., 2008).

105 By analyzing the situation of adults, women leave the STEM sector at much higher rates than men. Women represent 30% of researchers in STEM around the world, against to 53% of the world's bachelor's and master's graduates in the field. This gap varies from country to country due to different sociocultural facts (UNESCO, 2017). The leaky pipeline in STEM carreers represents a waste of social investment and individual effort, and suggests that there are structural problems around this scenario. The gender gap in STEM fields is certainly a complex issue, especially when considering intersectionality aspects

110 such as race, class or global scale cultural variations.

These data, while considering the specificities of each country and region, still show the persistence of a pattern: men are destined for areas popularly known as hard or difficult within STEM. The entrance and persistence of women in scientific areas is permeated by multiple symbolic references, implicit or not, that mark the limits of how far is possible to go within the power structure represented by science.

115 Some elements can influence the permanence of women in STEM courses, including the inspiration and support of close and influential people, such as family members and teachers (de Amorim et al., 2017). By staying in the courses, the construction of the academic career is also permeated by systems of oppression and power. Factors that influence women's permanence in careers in STEM include the compatibility that is perceived between certain STEM fields with female identity, compatibility with family obligations, and with the environment and working conditions. By analyzing the contribution of each gender in

120 the total of scientific publications in Brazil from the Scopus database, culminating in the publication of the report by Elsevier (Allagnat et al., 2017), it was disclosed that 49% of Brazilian publications are female researchers. Comparing the proportion of genders between different areas of research in Scopus, it can be seen that most female researchers are present in Medicine and Biological Sciences, while Engineering and Earth and Exact Sciences are predominantly male fields. In analysis of the Lattes platform, maintained by the National Council for Scientific and Technological Development (CNPQ), an average of 70% of

125 PhDs in engineering and 60% of PhDs in Exact and Earth Sciences are male (Allagnat et al., 2017; Lima, 2017).

There are multiple factors that overlap and influence girls' participation, performance, and advancement in women in STEM studies and careers, with all of them interacting in complex ways: individual, family, school, and social (Black, 2020). However, there are elements that permeate these distinct areas: machismo and patriarchy. According to Bellini (2018), patriarchy is a social organization that gives power mainly to older male figures, placing women in natural places of submission, while

130 machismo consists on a system of symbolic representations that contributes to constructions of relations based on the domination of a male subject over a female. As reported by (de Amorim et al., 2017, p.8) "in a sexist culture, in environments where they are a minority, it is common for women to suffer from sexist language and jokes or bullying, making them more uncomfortable and fragile" . Other elements can intensify violence against women: the prejudice for their race, social class, age and education. A popular black woman suffers much more than a white, upper-class woman, but both suffer gender violence

135 Ong et al. (2011); Bellini (2018). Considering that patriarchy, machismo and racism are structural and structuring within social contexts, they are also formulated by social subjects and can thus be modified by assigning new meanings to what is understood as common, as natural.

In trajectories analyzed by physics students, for example, they emphasized the solitary path within the academic life (Lima, 2013). Given the cold or hostile climate, either at the entrance or during academic life in STEM courses, Amon (2017) high-

140 lights the importance of spaces for socialization among women.

It is a common sense in the literature that education is crucial for reducing gender inequality in the areas of Exact and Earth Sciences, but the strategies may vary. In this paper, we are interested in strategies to mitigate the underrepresentation and to promote discussions on the glass ceiling issues.

2.2 The subjects

145 The University of Brasilia is the 4th most prominent university in Brazil, according to the "portal of transparency" (CGU, 2015) and its resources are distributed between four camps. Planaltina Campus (FUP) was implemented before the Federal Government's higher education expansion program. The Planaltina Campus corresponds to the region that aggregates Planaltina, Sobradinho, Brazlândia, Sobradinho II, Formosa, Buritis, Cabeceiras, Planaltina de Goiás, Vila Boa and Água Fria de Goiás. The Campus was officially inaugurated on May 16, 2006, with 70 students enrolled in the Natural Sciences Licensing and

150 Bachelor of Agribusiness Management courses, with ten PhD professors.

FUP exists for 13 years, being conceived in a plan of discentralization of the University infrastructure. The campus is situated 40 km away from the main campus, in Planaltina, a city of mainly lowincome population, surrounded by rural areas, which inspired the fact that all the offered courses are somehow related to earth sciences. Currently, the campus offers four

undergraduation courses, including natural sciences licensing, peasant education, agrobusiness and agroecology management.
155 Together, these courses offer today 420 annual chairs for higher education, including diurnal, noturnal and full shifts courses. The campus also houses seven graduate courses : Environmental Sciences (master's and doctoral degree), Materials Science, Science Teaching, Public Management, Water Resources Management and Regulation , Environment and Rural Development, and Sustainability with Traditional Peoples and Territories (master's degree).

Despite the effort of offering courses that are market demanded in the region, a research conducted as a final project by 160 one of Planaltina Campus students (Barros, 2013) showed that only 30% of Planaltina young population has the intention of accessing the university. From those, only 15% pretend to study exact and earth sciences.

Table 1. Proportion of male/female entrance, graduation and dropout rates at Planaltina campus, divided for each undergraduation course: natural sciences licensing daytime (CNN) and nighttime (CND), teaching degree in peasant education (LEDOC), environmental management (GAM) and agribusiness management (GEAGRO)

	Total		CNN		CND		LEDOC		GAM		GAM	
	M	F	M	F	M	F	M	F	M	F	M	F
Students entering FUP	45.9	54.1	46.2	53.0	41.6	58.4	38.6	61.4	50.1	49.9	53.3	46.7
Graduated students	39.7	60.3	36.9	63.1	36.7	63.3	30.2	69.8	43.1	56.9	47.1	52.9
Abandonment dropout	48.0	52.0	53.0	47.0	45.0	55.0	38.8	61.2	48.9	51.1	55.9	44.1
Course change dropout	50.6	49.4	42.9	57.1	40.7	59.3	0.0	0.0	66.7	33.3	57.5	42.5
Dropout for non-compliance with condition	52.8	47.2	45.2	54.8	42.9	57.1	42.0	58.0	65.4	34.6	67.2	32.8
Dropout for failing same discipline 3 times	50.0	50.0	39.1	60.9	41.7	58.3	60.0	40.0	57.7	42.3	54.2	45.8
Voluntary dropout	55.3	44.7	57.4	42.6	55.2	44.8	41.7	58.3	48.1	51.9	59.5	40.5

According to data extracted at the beginning of 2020, we can see that Planaltina campus follows the gender gap found in the literature from data on student enrollment and graduation in all courses. Table 1 shows that in three courses of FUP - natural sciences licensing daytime (CNN) and nighttime (CND), and the teaching degree in peasant education (LEDOC) the entrance 165 of female students is higher. These courses are degree courses for teacher training, which is a profession usually attached to women. Therefore the entrance of 54% women is expected. In other two courses, environmental management (GAM) and agribusiness management (GEAGRO) we observe, a slightly male predominance at entrance, and a reversal of the pattern for gradutation rates. We also notice that in those courses women dropout rates for failing university condition is much lower than for men, which indicate that women present more effort during their formation. Women are the ones who graduate most in all 170 FUP courses, with a total of 60.3%, but in the peasant education course it reaches 69.8% and in the courses with the highest number of men, the index graduation rates for women reaches 56.9% and 52.9%, increasing the proportionality in relation

to the entrance and raising the total graduation rate. The economic reports, though, show that these women do not achieve visibility even with higher earnings in graduation.

These data are in accordance with the studies made by PEREIRA (2015), who afirm that recent researches indicate that
175   women are the majority at all education levels in Brazil, including superior, and even though the courses with the most pre-dominance of them are in fact those considered as typically female, in the grand total they are still the majority. Guedes (2008) made a study about the female presence in university graduation and undergraduation courses, and afirm that the analysis of last IBGE census studies reveals that in thirty years women succeeded in reversing the historical inequality and consolidate a new reality in which they are the majority (60%) of the graduates among the most young.

180   At the same time, considering the types of dropout, there are more women who dropouts due to abandonment, but the value is proportional to the greater number of entries, while voluntary dropout is done in greater numbers by men (55.3%), configuring themselves in a high rate of dismissal of men in this modality. The other forms of disconnection behave erratically and need further studies to understand. The fact is that the FUP data do not escape from the gender studies already carried out in relation to the dedication of women to studies and the lack of recognition of this effort, therefore, the Women Scientists project has
185   been very important in inserting the gender debate in science and this debate has also been made through theater.

Planaltina campus is the most engaged campus with the population that surrounds the university. It has more than 60 projects and programs, led by the campus professors, staff and students, which promotes social activities, engaging the population and academia research. From those, at least three projects uses political theater as a tool to disseminate research findings, organize groups and capture and communicate knowledge about social relationships. Bleuer et al. (2018) argue that the capacity of
190   theater of capturing and communicating relational aspects are particularly useful for knowledge mobilization.

3   The project

The present work describes the activities of the project "Mulheres cientistas: desafios, mitos e resistência cotidiana", from portuguese "Scientist women: challenges, myths ans daily resistance". The project exists since the beginning of 2019, structured in activities to act, to feel and to think. In this manner, the act strand is based on a set of laboratory routines for high school
195   students is carefully prepared, with activities based on women's work, to promote repesentativeness and to rescue hidden figures of science history. The project also promotes a regular study group, that invites the participants to think about data, strucutral issues and to study feminist texts. And finally, we invite the public to feel how a scientist feels, how a woman feels, how relations are posed, using strategies from popular theater. The theater based activities are co-conducted with the program Terra em Cena.

200   The Terra em Cena program is one of FUP's extension programs with the aim of promoting articulated actions between teaching, extension and research (Boas et al., 2019). The program exists since 2010 with the scope of theatrical and audiovisual language, acting mainly with students from the Peasent Education undergraduation. Thus all the participants of the program are deepenly involved with peasent communities and settlements, often linked to social movements, or are part of the Kalunga quilombola territory (Gomide et al., 2019).

205   The provision of politicization of the experience through the Theater of the Oppressed and the contact with Brazilian dramaturgy that addresses issues of interest to the rural population enables the nexus between aesthetic and political formation and the community's social organization process. In the teaching degree program in Peasant Education, the work of the Terra em Cena Program collaborates with the promotion of multiple literacies (Freire and Macedo, 1987), by adding linguistic studies, written literacy, grammar and literature, to theatrical and audiovisual languages.

210   Part of Terra em Cena's activities involves action in the Brazilian capital equivalent to what is being done in the capitals of Argentina and Uruguay, in accordance to the orientation of the International Network of Theater and Society (Boas et al., 2019) for opening new training schools in political, audiovisual and arts, to offer political formation in the countryside and in the city, articulated with social movements.

       The ability of the theater for capturing and communicating knowledge about social relationships in ways that are not always
215   possible through texts (Bleuer et al., 2018), makes the Terra em Cena program an articulator of transdisciplinary activities.

       Throughout the Terra em Cena experience, the theme of patriarchy and feminism has been one of the main issues in the theater plays and audiovisual products of the groups that emerged from its performance. In this context, the participants of the project Mulheres Cientistas approximated to the theater activities promoted by Terra em Cena. With the intention of debating and combating gender oppressions in academia, with an emphasis on the particularities of exact and earth sciences, a set of the-
220   atrical and / or audiovisual sketches based on situations of harassment that are commonly denounced in this environment were put on scene, with the intention of explaining and discussing ways to foster gender imbalance in its most diverse perspectives.

3.1   The theater of the oppressed

The theater of the oppressed is the name that Augusto Boal gave to his systematization of theater techniques as means of promoting social and political changes (Boal and McBride, 2013). The scenes usually aims to reveal oppression situations, and
225   the audience takes place into the scene in active ways, becoming what is called "spect-actors". The spect-actors transform the reality in which they are living by exploring and transforming the scene. A major concept of the theater of the oppressed is that it is not enough to interpret the reality, it is necessary to transform it. We used two techniques from the theater of the oppressed in the project: the invisble theater and the forum theater.

       The invisible theater is a form of acting that the audience doesn't necessarily knows that a scene is taking place. It is possible
230   to present an invisible show anywhere the drama could really happen, or has already occurred (for example, in a laboratory, a meeting, a conference presentation or a cafe). It is an interesting form of organization, since there are no explicit spatial (auditorium and stage) or personal (actors and audience) hierarchic configuration. The key in an invisible theater intervention is its political effectiveness, by revealing contradictory dynamics through a scene represented with reality. To this end, it is necessary to develop the aesthetic effectiveness of the scene.

235   Acording to Boas (2019), a successful invisible show must follow some basic rules, such as "Actors should never commit any act of violence against or intimidate spectators - their actions must always be peaceful, as they are revealing the violence of society as it exists, not duplicating it", "the scene must be as theatrical as possible, and must be bale to unfold even without the participation of the spectators" or "One should never perform an illegal act, since the aim of the invisible theater is precisely to

question and challenge the legitimacy of legality." The invisible theater demands particular efforts on rehearsing not only the
240 predictd scene, but also any possible or predictable interventions by future spectators.

As the invisible theater, the forum theater also aims to make oppression visible, but in this arrangement, the scene is explicit, and the show acts as a forum to help people understand how they can change their world. Audience members become actors in key moments of the proposed scene, directing the way the play reaches its climax through changes on a specific behavior of a character, or by modifying a given configuration. Forum Theater is historically used by social movements, but it is also being
245 used by researchers and policy makers to communicate science and to discuss problems in a contextualized way (Strickert and Bradford, 2015).

In a psychological point of view, theater enables audience members to cultivate greater empathy for the issues witnessed on stage (Bleuer et al., 2018). In particular, theater is an extraordinary tool to gender issues in science mobilization, taking into account that beyond explicit violence and harassment against women, subtle violence (and legal violent acts) are understood
250 with empathy through theatrical acts, which doesn't necessarily happen through direct presentations or reports. In this sense, our group developed some scenes based on the invisible theater, that are performed during public talks at the university, or during our science labs to students, revealing micro and macro sexist situations, specially in academic environment. The performs usually have a silent impact, that can be noticed on a general change of behavior from participants and spectators, which reveals a level of empathy that grows from the act. We also developed forum theater scenes, from where we noticed
255 particular challenges, that comes from the fact that forum theater deals with an immediate intervention from the audience.

A known experience of feminist theater is the group led by Muriel Naessens, in France, Feminism-enjeux (Ferré, 2019). What we get from our experience and from Ferré (2019) report on Feminism-enjeux issues, is that violence against women, specially subtle violence, accepted socially, is that in forum theater experiences, is not uncommon that the spectactor brings to the stage solutions based on the empowerment of the oppressed woman solely, as if the victim was also the responsible
260 for its own oppression. Thus some interventions are made necessary, to guarantee that the concept of private violence is a public concern is well understood by all participants. In other words, the participants must be aware that only collective action, legislative innovations and public policies truly transform reality.

3.2 Creating the play

In the scope of the project "Mulheres cientistas", we used forum or invisible theater for each presented context. At schools
265 activities, and workshops offered at the university, we used forum theater schemes to promote particular discussions brought up by the workshop participants. We used the invisible theater in public situations at the university, such as presentations of projects to colleagues, or management meetings. The scenes were ellaborated and performed by professors and students. The studies groups were useful to collect data, information and thoughts to base the script and to predict possible reactions.

A main goal of the project is to reveal structured oppressions, not necessarily related to academia, but that necessarily
270 influence academic paths. Paternalism and intrinsic macho culture makes it difficult to perceive harassment situations to which all women are subjected in daily life, that can happen in a simple trip to the supermarket, a business meeting, a college

class or a domestic situation. The idea of portraying some scenes was to get in touch with these situations revealing different scales and levels of the consequences of this society structure.

The first elaborated scene brings a clipping of a family that presents a woman, mother of two pre-teens, researcher and wife.
275   The scene also features another woman, the housekeeper and nanny of this family, who is also the mother of a girl.

The scene begins with the tired researcher of a sleepless night working on a project, and dealing with the two children who stay on the cell phone all the time and argued tirelessly. At that time the housekeeper arrives, but she was late because she wasn't able to take the transport on time due to precary conditions of public transportation.

At this point, the housekeeper reported that the only alternative to get to work after a long wait was to take a crowded
280   transport, and that she felt intimidated and afraid of suffering sexual harassment in the bus, a common situation when the bus is crowded.

The scene continues with the housekeeper taking care of the house, the chaos that was the relationship of children while the researcher finishes her project with a new coffee. At this point the housekeeper's daughter calls her asking for a material to school and she responds saying that there is no way to buy it because she will come late from work. The scene has the intention
285   to show the contradictions of the relations of these two women. They confide their difficulties at work and in life. One has spent all night working on the project that has not even finished and the children do not rest until the housekeeper would arrive and take care of them. The housekeeper, on the other hand, is barely able to get to work because of the transportation in which she is likely to be harassed, she goes to work all day caring for her mistress's things and children but will not have time to take care of her own daughter's demands. It is a relationship of complicity and contradiction at the same time.

290   In another part of the scene the researcher has a clash with her daughter who needs to get ready to go swimming class. The mother asks her daughter to wear a more "well-behaved" outfit because the girl is wearing shorts and a low-cut tank top so she will be harassed. And the fight revolves around the mother wanting to preserve the daughter from harassment and the daughter to defend the right to dress like this because it would be very hot.

The final part of the scene shows the researcher talking on the phone with her husband. In the call he says that that day he
295   can pick up the girl in the swimming class, which makes she feels relieved and grateful that he will be able to finish the late work she was doing. For a moment, within the reflection of the character she is extremely grateful to have a good husband who helps her with her children when she needs it. In the next instant she realizes that it is actually his function to care of the children, thus ending the first scene, and starting the discussions.

The second scene features a meeting between researchers discussing the organization of a scientific conference. In this scene
300   we have three female researchers and three male researchers who present themselves as invisible men (the actors are not on the scene). The scene begins with one of the female researchers reading the agenda, being constantly interrupted by one of the researchers, until one colleague interferes and asks him to stop so that the other can continue.

After the agenda of the approved meeting goes to the discussion of the definition of the event coordinator. The male researchers propose a senior researcher who coordinated previous editions, but is never present in any meeting, and the female
305   researchers advocate the name of a woman that is truly involved with the event for coordination. She accepts the nomination for coordenation, suggesting that the senior researcher should be invited as support so that joint work will be necessary due to

her experience and network. At this point, the women in this group show how they prefer to work in a collective and supportive network, and bring up the matter from the scientific committee where men only bump men's names. The last agenda item is the responsibility of the local organizing committee, which none of the men present wants to coordinate. It is stated that all the

310 women at the table have already played this role and that they are neither secretaries nor party organizers, yet men are reluctant to play secretarial roles, or secondary activities.

Before the meeting is over, one of the invisible male researchers gets up to leave saying he needs to pick up his son from school. Two of the women find the attitude of a good father beautiful, as he takes good care of his son and compliments him. The third, is not moved by the scene, because when a woman plays the same role the scene is not touching, but negative

315 judgment usually takes place.

These scenes, which sought to show how patriarchy affects professional roles between men and women, brings interesting discussions on why women still have to impose themselves to not always be subdued, or how the system imposes that women depends on other women to take care of their children and houses.

Another act that the group Mulheres Cientistas performed was an invisible theater scene. During a presentation of the

320 project at the university, a male colleague and theater professor was invited to promote what is called "mensplaining" in the feminist recent literature, which means that a man keeps explaining what a woman has just explained, as if the way she communicates in a group is not sufficiently clear. So, during the explanation of the project, the professor would constantly interrupt the talk to congratulate the project, and to re-explain what was already explained. This is a very common situation, that is often unconfortable, because it steals from the woman the centrality of the talk. On the other hand, it can be a very subtle

325 oppression, since all the comments were favourable and sweet. When the scene was revealed in the end of the presentation, a big contradiction was set. The vast majority of the audience didn't realise that a scene was taking place, as if it was normal to have a person in the audience re explaining the talk. Only women related they felt unconfortable with the constant interruptions.

3.3 Gender debates at basic education

The group developed a set of laboratory routines on a classroom goal orientation to female scientists' role models directed to

330 students from 8th to 12th grade. To evaluate the routines, we adopted a scale of attitudes towards science gender (Aiken and Dreger, 1957). Initially, all the subjects (males and females) answered a list of questions to understand their science knowledge background as such: Q15 - "What is your favorite course at school?" and Q16 - "What is your least favorite course at school?". We noticed that math seems to be a male preference, while language and arts seems to be a female oriented choice. Interestly, science showed an almost 50/50 percentage gender choice in both questions,

335 Beyond preferences, gender imbalance in science courses might also grow from how the students perceive themselves when compared with others regarding their grades. Aiken and Dreger (1957) showed that the presence of negative stereotypes can hamper girls' performance when compared with the boys leading to a gender gap in young children's science ability. Our result showed that girls believed they have grades below class average whereas boys saw themselves above the class average. The presence of negative stereotypes among girls considered to be one of the causes (indirect or direct) of the under-representation

340 of women in STEM.

The background of our subjects inspired us to develop a set of laboratory routines that could deal with the attitudes on performance. The lab activities was proposed with the intention of, in addition to providing access to new scientific methods and concepts, also providing the rescue of biographies of women scientists, so that somehow the stereotype that science is for men is gradually demystified.

345 One example is the laboratory routine based on the Field's medalist mathematician Maryam Mirzakhani, and her studies on non-Euclidian geometry. We performed an active methodology regarding geometry using a 3D stereographic projection of a sphere on the walls at the classroom to all students. This projection was performed using students' cell phones flashlights into 3D printed spheres and pseudo-spheres. Non-euclidean geometry is not intended for the high school curriculum, so the lab routines increment the scholar activities by bringing new concepts that can be related to the curricular geometry. Withal the

350 routine shows that science and mathematics are dynamic disciplines, when we show results from contemporeneous researchers. And finally, we show that women also deliver to society important results. In the case of Maryam Mirzakhani lab, we bring the discussion about gender imbalance in science award, and how the indications are made. These discussions are also a source for new forum theater scripts.

4 Results

355 The group performed 4 times using different theater of the oppressed techniques during the second semester of 2019. The first perfomance occurred during a workshop at the University for external public. 30 people participated, between 19 and 50 years old, with 40% composed by university rural students, 30% university urban students and 20% by external (from the university) public. After a discussion about gender imbalance in science, the workshop participants were divided into 4 subgroups, where each group constructed a scene. Despite the focus of the workshop was clearly on gender imbalance on

360 STEM, all the groups constructed scenes about private life situations, such as child care, domestic violence or sexual division of domestic work. We evaluate that the choices of the sketches topics are always related, directly or indirectly, to personal experiences. We expected initially that the participants would bring scenes strictly related to academic environment gender oppressions, such as skecthes of moral or sexual harassments from professors, but the results showed that the theater has the potential to deepen the understanding of a concept by connecting real data to personal experiences. Theater experience made

365 it clear that gender imbalance in STEM is a social structured topic, where bridging the gap will only happen with broad public policies for women. We also evaluated from the first workshop that theater is a safe place to discuss private life issues, because the public never knows if the scene is based on real facts or not. In a context of high rates of dropouts and psychological disturbs among students, theater seems to be an ideal tool to mitigate some relational challenges that are common and also mysterious at the university.

370 The second scene happened during an event, where we promoted the forum theater perfomance that we described in this text. The scene was fulled of contradictions: the researcher and housekeeper relationship, the mother relation with her children, and the unbalanced relation between women and men professors at a meeting. On that opportunity, the audience was highly diverse, with students, professors and staff, but only students proposed changes on the scenes, and the proposals were mainly

on the housekeeper and researcher relationship. There was an explicit discomfort with that structure, where a set of gender
375 oriented layered oppresssions are imposed, while a cruel class division also takes place. Once more, the private life aspects
got more attention, and it was interesting to notice that no interferences on the meeting configuration was proposed by the
audience.

Our third performance was the invisible theater scene that happened at the campus, during a public presentation, where we
simulated a "mensplaining" situation. We evaluated that invisible theater has a great potential of promoting silent reflections
380 on people's own behavior. Although we still don't have the means to present a quantitative result of the impact of the scene,
we would like to register that the experience reverberated in our community in a positive way. We received relates from male
professors that after the scene, they started to police themselves in order to avoid undesirable situations. We also evaluate that
theater is suitable to mitigate university dropouts. To illustrate the theater potential on this concern, a student related to us that
gave up from dropping out the university when she realized watching one of the project presentations that she was not the only
385 girl that had the feeling that university was not designed for her, or that she should be at home taking care of her brother.

Finally, we promoted a workshop in a public high school, with 70 students from 15 to 16 years old. The students were
divided into 7 groups, and after a discussion on gender imbalance in STEM, they proposed their sketches. This time, the
sketches were centered on the university access. The groups performed situations that they believed to limit their admission
at a public university, such as police violence in front of the school, drug dealing at school, precarious public transport, lack
390 of adequate places to study at home and the absence of good public libaries near their houses. It was interesting to notice
how different but relevant topics appear in each time a workhop is promoted with a different public. Theater allows personal
experiences to be discussed in an organized and systematized way, without exposing intimacies. The mixture of real facts with
theatrical elements makes the actor or actress confortable to expose intimate feelings or nuisances.

5 Conclusions

395 Our first goal was to bring into the university the discussion about gender gap in STEM carreers. We tried two different
approaches: bringing renomated scientists to public talks and debates, and created a group of studies, with students from
three different courses. The debates were interesting, but the activities were punctual and did not reverberate within the entire
campus community. The idea of the groups of studies was to give continuity to the debates. The bibliography of the study
group was vast, and the students were engaged with the theme. The most interesting part of the group, though, happened when
400 students brought into discussion their personal experiences, because it was at this point that the debate was incorporated by the
participants. However, talking about personal experiences is usually delicate, and it demands a lot of time from the entire group,
to listen, and to promote a safe place for confidences. Thus we noticed that we had to provide a methodology that was capable
of systematizing all the exposed experiences, without exposing intimacies and that could be performed in an organized amount
of time. At the same time, we wanted to propose a method that could inspire changes to the reality that was being described by
405 the participants. We used the data collected from the study groups to create the characters, the forum theater components and
the invisible theater sketches.

We observed that political theater is a source of research to identify the causes of our high rates of droputs, to investigate how our students perceive gender issues in their personal lives and how all aspects of social relations affect the gender imbalance in academia. As researchers and professors, it is imperative that while we advance in our own research, we also advance in
410   promoting equality in academic work environment, within its all stages. It is clear to us that gender imbalance in STEM careers affects not only academics, but also all societal structure. Having more women studying and working in STEM areas is to guarantee the future of a society where men and women have balanced job opportunities, and where technology is developed to promote the interests from both men and women.

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415   ground formulation. Gustavo Alcântara took the lead in conducting the basic education workshops and compiled results from the queries. Cynara Kern and Elisabeth Andreoli described the theater scenes. Lyvian Senna conducted the theater workshops and was also the director of the theater group. Caroline Gomide and Leandro Evangelista compiled data about the University of Brasilia students. Susanne Maciel took the lead in writing the manuscript. All authors provided critical feedback and helped shape the research, analysis and manuscript.

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References

Abouzahr, K., Krentz, M., Taplett, F., Tracey, C., and Tsusaka, M.: Dispelling the myths of the gender "ambition gap", Boston Consulting Group, http://image-src.bcg.com/Images/BCG-Dispelling-Myths-of-Gender-Ambition-Gap-Apr-2017-Revised{_}tcm9-150012.pdf, 2017.

Aiken, L. R. and Dreger, R. M.: the Effect of Attitudes on Performance, Journal of Educational Psychology, 52, 19–24, 1957.

Allagnat, L., Berghmans, S., Falk-Krzesinski, H. J., Hanafi, S., Herbert, R., Huggett, S., and Tobin, S.: Gender in the global research landscape, Tech. rep., https://doi.org/10.17632/bb3cjfgm2w.2, https://www.elsevier.com/{_}{_}data/assets/pdf{_}file/0008/265661/ElsevierGenderReport{_}final{_}for-web.pdf{%}0Ahttps://www.elsevier.com/research-intelligence/campaigns/gender-17, 2017.

Amon, M. J.: Looking through the glass ceiling: A qualitative study of STEM women's career narratives, Frontiers in Psychology, 8, 1–10, https://doi.org/10.3389/fpsyg.2017.00236, 2017.

Barros, L. V.: Intenção de ingresso dos alunos do ensino médio das escolas de Planaltina no curso de Licenciatura em Ciências Naturais da Faculdade UnB de Planaltina, Ph.D. thesis, 2013.

Bellini, D. M. G.: Violência contra mulheres nas Universidades: contribuições da produção científica para sua superação (Scielo e Web of Science 2016 e 2017)., Ph.D. thesis, 2018.

Black, C. F.: Global Gender Gap Report, Tech. rep., World Economic Forum, Geneva, https://doi.org/10.1002/9781119085621.wbefs350, 2020.

Bleuer, J., Chin, M., and Sakamoto, I.: Why theatre-based research works? Psychological theories from behind the curtain, Qualitative Research in Psychology, 15, 395–411, https://doi.org/10.1080/14780887.2018.1430734, https://doi.org/10.1080/14780887.2018.1430734, 2018.

Boal, A. and McBride, C.: Theatre of the Oppressed, Theatre Communications Group, https://books.google.com.br/books?id=m1j6CAAAQBAJ, 2013.

Boas, R. L. V.: Invisible theatre: from origins to current uses, in: The Routledge Companion to Theatre of the Oppressed, edited by Howe, K., Boal, J., and Soeiro, J., pp. 162–167, Routledge, 1st edn., 2019.

Boas, R. L. V., Pinto, V. C., and Rosa, S. M.: The School of Political Theater and Popular Video of Federal District: formation by praxis, Urdimento, 1, 36–47, https://doi.org/10.5965/1414573101342019036, 2019.

Carey, M., Jackson, M., Antonello, A., and Rushing, J.: Glaciers, gender, and science: A feminist glaciology framework for global environmental change research, Progress in Human Geography, 40, 770–793, https://doi.org/10.1177/0309132515623368, 2016.

CGU: Portal da Transparencia, http://www.portaltransparencia.gov.br/?minifiedPath=%2Fminified&projectVersion=1.16.1, 2015.

de Amorim, V., Dantas, M., and de Carvalho, M.: Estratégias De Superação Utilizadas Por Mulheres Recém-Doutoras Em Física, in: Seminário Internacional Fazendo Gênero 11& 13thWomen's Worlds Congress, pp. 1–11, Florianópolis, SC, 2017.

de Melo, H. P. and Oliveira, A. B.: A produção científica brasileira no feminino, Cadernos Pagu, pp. 301–331, https://doi.org/10.1590/s0104-83332006000200012, 2006.

Dickhäuser, O. and Meyer, W.-U.: Gender differences in young children's math ability attributions, Psychology Science, 48, 3–16, 2006.

Duncombe, J.: Shining a spotlight on LGBTQ+ visibility in STEM, Eos, 100, 0–1, 2019.

Ferré, G.: Féminisme-enjeux: challenges and paradoxes of a feminst Theatre of the Oppressed company, in: The Routledge Companion to Theatre of the Oppressed, edited by Howe, K., Boal, J., and Soeiro, J., pp. 375–380, 2019.

Ford, H. L., Brick, C., Azmitia, M., Blaufuss, K., and Dekens, P.: Women from some minorities get too few talks, Nature, 576, 32–35, 2019.

Forum, W. E.: World Economic Forum Report, http://reports.weforum.org/global-gender-gap-report-2020/, 2020.

Freire, P. and Macedo, D. P.: Literacy: reading the word & the world, Bergin & Garvey Publishers, 1st edn., 1987.

Ginther, D. K. and Kahn, S.: Comment on "expectations of brilliance underlie gender distributions across academic disciplines", Science, 349, 391–b, https://doi.org/10.1126/science.aaa9632, 2015.

Gomide, C. S., Villas Boas, R. L., Martins, M. L., Gouveia, L. R., and Dias, A. L.: Rural Education and Pedagogy of Alternance: UnB experience in the Kalunga historical site and cultural heritage, The Brazilian Scientific Journal of Rural Education, 4, 1–27, https://doi.org/10.20873/uft.rbec.e7187, 2019.

Grogan, K. E.: How the entire scientific community can confront gender bias in the workplace, Nature Ecology and Evolution, 3, 3–6, https://doi.org/10.1038/s41559-018-0747-4, 2019.

Guedes, M.: Women's presence in undergraduate and graduate courses: deconstructing the idea of university as a male domain, História, ciências, saúde, 15, 117–132, 2008.

Holmes, M. A.: Gender imbalance in US geoscience academia, Nature Geoscience, 9, 8–82, https://doi.org/10.1038/ngeo113, 2008.

Holmes, M. A., Asher, P., Farrington, J., Fine, R., Leinen, M. S., and LeBoy, P.: Seafloor Seismometers Monitor Does Gender Bias Influence Northern Cascadia Earthquakes Awards Given by Societies ?, EOS Trans. AGU, 92, 421–422, https://doi.org/10.1038/ngeo113., 2011.

Kersey, A. J., Braham, E. J., Csumitta, K. D., Libertus, M. E., and Cantlon, J. F.: No intrinsic gender differences in children's earliest numerical abilities, npj Science of Learning, 3, 12, https://doi.org/10.1038/s41539-018-0028-7, http://www.nature.com/articles/s41539-018-0028-7, 2018.

King, L., MacKenzie, L., Tadaki, M., Cannon, S., McFarlane, K., Reid, D., and Koppes, M.: Diversity in geoscience: Participation, behaviour, and the division of scientific labour at a Canadian geoscience conference, Facets, 3, 415–440, https://doi.org/10.1139/facets-2017-0111, 2018.

Leslie, S.-J., Cimpian, A., Meyer, M., and Freeland, E.: Expectations of brilliance underlie gender distributions across academic disciplines, Science, 347, 262–265, https://doi.org/10.4135/9781483392240.n8, 2015.

Lima, B. S.: O labirinto de cristal: As trajetórias das cientistas na física, Revista Estudos Feministas, 21, 883–903, https://doi.org/10.1590/S0104-026X2013000300007, 2013.

Lima, B. S.: Políticas de equidade em gênero e ciências no Brasil: avanços e desafios, Ph.D. thesis, 2017.

Minella, L. S.: Temáticas prioritárias no campo de gênero e ciências no Brasil: Raça/etnia, uma lacuna?, Cadernos Pagu, pp. 95–140, https://doi.org/10.1590/S0104-83332013000100003, 2013.

Neugebauer, K. M.: Keeping tabs on the women: Life scientists in Europe, PLoS Biology, 4, 494–496, https://doi.org/10.1371/journal.pbio.0040097, 2006.

Ong, M., Wright, C., Espinosa, L. L., and Orfield, G.: Inside the double bind: A Synthesis of empirical research on undergraduate and graduate women of color in science, technology, engineering, and mathematics, Harvard Educational Review, 81, 172–208, https://doi.org/10.17763/haer.81.2.t022245n7x4752v2, 2011.

Patridge, E. V., Barthelemy, R. S., and Rankin, S. R.: Factors impacting the academic climate for LGBQ stem faculty, Journal of Women and Minorities in Science and Engineering, 20, 75–98, https://doi.org/10.1615/JWomenMinorScienEng.2014007429, 2014.

PEREIRA, A.C.F., F. N.: História da mulher no ensino superior e suas condições atuais de acesso e permanência, in: VI Seminário Internacional sobre profissionalização docente, pp. 5527–5542, 2015.

Reinking, A. and Martin, B.: The gender gap in STEM fields: Theories, movements, and ideas to engage girls in STEM, Journal of New Approaches in Educational Research, 7, 148–153, https://doi.org/10.7821/naer.2018.7.271, 2018.

495 Renki, M.: Opinion | How to Talk to a Racist - The New York Times, https://www.nytimes.com/2018/07/30/opinion/how-to-talk-to-a-racist.
      html, 2018.

Rosser, S.: 2004.

Stoet, G. and Geary, D. C.: The Gender-Equality Paradox in Science, Technology, Engineering, and Mathematics Education, Psychological
      Science, 29, 581–593, https://doi.org/10.1177/0956797617741719, 2018.

500 Strickert, G. E. H. and Bradford, L. E. A.: Of Research Pings and Ping–Pong Balls: the use of forum theater for engaged water security
      research, International Journal of Qualitative Methods, 14, 1–14, https://doi.org/10.1177/1609406915621409, 2015.

Sylvia, B., Hewlett, A., Luce, C. B., Servon, L. J., Sherbin, L., Shiller, P., Sosnovich, E., and Sumberg, K.:
      The_Athena_Factor_Reversing_the-2, 2008.

UNESCO: Measuring Gender Equality in Science and Engineering: the SAGA Toolkit - Working Paper 2, Tech. rep., UNESCO, Paris,
505   http://unesdoc.unesco.org/images/0025/002597/259766e.pdf, 2017.