

From School to University: An Overview on STEM (Science, Technology, Engineering and Mathematics) Gender in Brazil

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Abstract

Since centuries ago, women have been seeking gender equity's guarantee and even with the right to poll, divorce, work and education, it didn't mean an equality of place in universities. Even though they are majority in Brazilian universities, this doesn't reflect itself in what relates to the permanence and career's ascension in Exact Sciences field. A minimum number of women graduating in licentiate and bachelor degrees, though when they become researchers few ones achieve a productivity fellowship. Moreover, black women's situation is even more vulnerable. In basics education, a little number of women teaches disciplines related to Physics or Mathematics, making that students don't fell represented.

In this work is brought about a survey on ethnic/gender representativeness in database and together with students from middle/high school. The results of our study demonstrate that affirmative policies are needed to gender and ethnic equity in exact sciences yet. Not only in what refers to representativeness in researches and universities, but also aiming basics education's schools. Encouraging the deconstruction of stereotypes and that more women, especially the black ones, can ingress on those graduation courses related to this scientific knowledge's field.

Keywords: Education, Gender, Human Rights, Physics, Stereotypes.

1. Introduction

Affirmative actions are constituted as a group of policies that has as object itself to protect minority groups from discrimination and in inequality situation be professional, racial, ethnic or social. Beyond seeking the promotion of processes that aim gender equity, ethnicity, social, among others [1]. Mostly, society tends to associate affirmative actions' policies adopted by universities only to the implementation of ethnics and social quotas for the access of this minority to higher education, especially to the public. However, much before the implementation of such actions cited, many public institutions had already adopted policies of student permanency, mostly known as student assistance, for students from low income be in graduation as post-graduation level, through the concession of financial aid, student accommodation and university restaurant. Among many institutions we can cite: Federal University of Minas Gerais (UFMG), Federal University of Rio de Janeiro (UFRJ), Federal Rural University of Rio de Janeiro (UFRRJ), University of São Paulo (USP), State University of Campinas (UNICAMP). Further the victories obtained by the black movement and society organized by affirmative actions, we also can cite some descendant from the feminist movement's fight, that in the recent years, pressed the universities to grant an assistance and permanence policy to mothers women, those having now, the right of student accommodation granted for them and their children, for example, in the case of USP and UFRRJ, that have housing to mothers/family. Beyond that, movements organized by women in Brazilian universities, as example the group "Me Avisar Quando Chegar" (Tell Me When You Arrive) from UFRRJ, is fighting against harassment / sexual assault and rape inside those institutions, for appropriate safety conditions to the female students and that many times go against more diverse interests or against sexism that turns those women invisible or even makes them afraid of complaining.

Feminism is the movement, which for centuries, fights for the equalization of rights between men and women, those rights may be social or political, in and outside universities' walls. In Brazil, women have faced various social and political hindrances to get access to education, especially the higher one. The diverse historical reports, though they don't have an accurate date, indicate that the feminine ingress in university happened in the decade of 1880, influenced by the arrival of the royal family in the country and the independence of Brazil [2]. However, slavery was still in force, not allowing the same right to black women.

Feminism, with its distinct strands, centuries later, keeps itself modern and with its strength rescued in the last decade. Even though women have advanced in conquers like the right to poll, divorce, heritance, employment and others, it didn't mean they have got the same rights as men. This confrontation continues to be fought in various spaces and both

University and Scientific Academy don't get away from this context. It continues to be a challenge to women, the scientific career in Exact Sciences and particularly in Physics' area. Access is still very restricted in Science known as "hard", taking up longer to constitute a scientific career. In general women need to conciliate motherhood and other caring functions inside family, roles attributed to them historical-socially. Social perception those roles are destined to women, mostly assuming double or triple journey, gets scientist to relegate their careers to the background and, for many times gets them to be seen as little commitment people or unavailable to the professional career. It's usual in post-graduation or contests interviews, women to be consulted about their civil state and about their intent of pregnancy.

They don't receive the same treatment given to the opposite sex pairs. And aiming our vision to the black women in Exact Sciences the vulnerability situation is even bigger. In a way that becomes urgent the discussion and implementation of affirmative actions for access, permanence and ascension of women in scientific careers among Exact Sciences and even more urgent the needing to aware of the strong oppression in academy, where the most affected are black women.

In this work we sought to discuss gender questions in scientific career's scope in Exact Sciences' field, taking into consideration the necessity of the comprehension of feminist movement and human rights' importance. We conducted a data collection o referring to the scientific community in Exact Sciences in the country and a quantitative analysis of women researchers acting in departments of Physics in Universities from the metropolitan region of Rio de Janeiro. Beyond that, we performed a project with students from middle and high school of Rio de Janeiro, seeking to evaluate their perceptions about who represents Science in their daily routines and in which way it would relate to the obtained results with the data collection cited. From the comprehension of the data relation in different spheres, we sought to discuss the relevance of affirmative policies of gender in Exact Sciences, that still have a fewer space in relevant academic journals.

2. Feminism, Human Rights and STEM

The UN approved Human Rights' declaration in 1948. However, the fight for the guarantee of human dignity is far antique, resembling about 500 B.C., when the Persian king, Ciro, assured freedom of slaves and rights associated to human dignity and that had been recorded in "Ciro's Cylinder". Other historical occasions in the fight for Human Rights were **The Virginia Declaration of Rights** in 1776 (USA) and **The Declaration of the Rights of the Man and of the Citizen** in 1789 (France) [3].

There are no doubts of the importance of the Declaration of the Rights of the Man and of the Citizen, as first universal document, that sought to guarantee freedom and

equality of the citizen. More than 150 years later, it influenced in the building of the Human Rights' declaration from the UN. It's product from the French Revolution and ideals, where men and women fought together for such conquests. Still, that declaration excluded from women, poor and foreigners the warranty of the rights correlated to citizenship, equality and liberty. The 1791's constitution, just considered "citizen" French men and property owners with high annual income. Unique qualified to poll in the assembly. Compromised with bourgeoisie, prohibited women's rights, which also have fought in the revolution for such assurances [4].

We observed that gender discrimination already showed itself even in a historical moment and with a fundamental value of the Human Rights. The rights, in this historical occasion, were only for men. Thus, we have the fight that will give origin to feminism as a movement, where women seek until nowadays to guarantee basics rights as education, employment as well as life, since daily news in Brazil about femicide or the gender violence that disturbs women in Brazilian universities as in Federal Rural University of Rio de Janeiro's case, as discussed by Rosa in a wide study to comprehend the question [5].

Among one of the first exponent of the feminist movement we have the English writer Mary Wollstonecraft, that in the midst of other fights, pursued the right to education of women and to have the power to educate their own daughters as she writes in "Thoughts on the Education of Daughters" (1787) [6]. Even though, all of her effort little was the advance in women's fights for their rights. It would be only almost one century later that the feminist movement would gain more strength and visibility, especially indeed to the suffragettes in England in the end of XIX century, leaded by Emmeline Pankhurst. Since then, in XX century, the movement will pass through three waves, dividing itself in many strands until it comes to nowadays. One of these important strands is the emergence of the black feminism. Once black women, besides the oppression of society and men, feel the oppressive hand of white women, which mostly were their employer. Among the protagonists of this movement we can cite Angela Davis, bell hooks, and recently in Brazil, Djamila Ribeiro. "The divergence is due, essentially, to the difference between social roles, historically, played by black women, foreigners and white women." While Simone Beauvoir [7] analyses women as a sociocultural building, as long as you are not born as women, but you become one by multiples processes, without ever reaching equalization with men. Beauvoir criticized the construction that relegates to women the position of civil incapability, even after reaching adulthood, passing from parents' custody to husband's guard, without conceding the right to be an independent subject. Her adulthood is watched by her father, husband, or any male relative, for the exercise of citizenship, never plenty. Black women were never inside this construction.

It's important to highlight that black feminism consider experience's diversity both from women and men and the different possible points of view of a phenomenon analysis, as well as to mark the place of speech of whom proposes it. When Patricia Hill Collins talks about this conception, makes use of the concept of domination matrix to think of the intersection of the inequalities, in which the same people may find themselves in different positions depending on their features. Moreover, it is exactly in this cross among gender, race and class where the black woman is. Thus, gender analysis should also consider not only questions related to the access to education, additionally as a set of aspects that evidence the hierarchical relations reproduced inside the educational system. When it's analyzed the situation of black women in higher education, it's needed to investigate not only where these are found in the referred educational level, but their position in relation to the others groups that compose Brazilian academic community [8].

Nowadays, women still come across the repetition of the same speech of "fragile sex", and in the thesis of male supremacy as a Christian principle, once Christ was a man, to what Sojourner countered with the next words: "That little man in black there, he says women can't have the same rights as men because Christ was not a woman. And Christ came from where?" [9].

Black women, since slavery period, already had their cheap work force equivalent of a man. While to white women, the cited rights were denied and the role that fit them was the caring of family and home, to black women, since slavery advent, transited in the middle of the roles of reproducer, slave labor, rural worker, house worker, and sexual object. To the black women always was applied, yet in a compulsory way, the hard work. There isn't, historically, to her the role of "watched", of living being to be cared, this being the root of divergence, making the emanation of black feminism. Authors like Angela Davis, bell hooks, Faye Harrison, Neusa Moreira, Djamila Ribeiro, Giovana Xavier and many others, have been developing the rescue work of the social-political role of the black woman in the history of humanity's achievements, may be in political, technological or social area.

Currently, even though women are majority in Brazilian higher education, answering for 57,2% of students, it isn't reflected in the number of professors of Higher Education Institutes (IES), where those represent 45,5%, according to the last Higher Education Census fulfilled by INEP [10]. Conform a study accomplished by Elsevier in global scale, in the group characterized as professor researchers, women represent about 40% and if we focus on STEM areas, this percentage falls to less than 25% [11]. Women are affected by the leaky pipeline effect along their academic development, that is, they pass to compose an each time smaller number as getting higher in academic hierarchical level [12, 13]. It is noted

that among Brazilian Physics Society, women represent nearly one fourth of the members, with similar numbers in Brazilian Astronomic Society. This leaky pipeline effect indicates being associated not only with social and historical constructions attributed to women by patriarchy, but also to gender violence suffered by students and scientists in Exact Sciences in universities, as discussed by Morcelle [14] and Aycock [15] in their works made in Brazil and United States, respectively. Demonstrating that still occur severe violations of human rights in academic and research space.

3. Material and Methods

The National Council of Technological and Scientific Development (CNPq), is an agency attached to the Brazilian Ministry of Science, Technology, Innovations and Communications (MCTIC), which has as main function to promote researchers' formation in the diverse areas of knowledge. Spite its wide database, we made a survey of the distribution of research scholarship since graduation until the higher level of incentive to scientific research in Exact Sciences field that is the productivity fellowship program. As since 2013, CNPq allows the voluntary declaration of race, our data were split in virtue of ethnic and gender relation. It fits highlighting, that the presented data are referred to the interval from 2013 to 2017, since we do not have access to the data in the biennium 2018-2019. In this stage, we seek to compare the percentage of women involved on research in Exact Sciences and how this number is related to international data of feminine representativeness in this specific field.

In a second stage, taking in consideration our acting area, that is Physics and our main acting region, which is the city of Rio de Janeiro/Metropolitan Region, which represents a large part of the research made in southeast region. We sought to analyze the proportion of women researchers in Physics that act in this geographic location. This comprehension is important, since these university female professors are responsible for the academic and scientific formation of our students, turning possible to identify the regional representativeness in relation to national and international data. Therefore, it was accessed the internet sites from the departments/institutes of Physics from Federal University of Rio de Janeiro (UFRJ), State University of Rio de Janeiro (UERJ), Federal Rural University of Rio de Janeiro (UFRRJ), Pontifical Catholic University of Rio de Janeiro (PUC-Rio) and Federal Fluminense University (UFF), since those are the only ones that offer Physics course in the interest region.

Facing the results obtained in the data collection in CNPq and Universities, we developed a project together with basics education's students, with the aim of comprehending if, yet in scholar time, there is a gender/ethnic stereotype, which can influence the perception of whom occupies the scientist place.

The first step with the students was a test appliance, where we requested that they drew a person who exerts the scientist profession. Subsequently, it was showed a photo board, mainly with scientists, among men and women from different ethnicities. All the work was made in a way of not using gender identification, adopting structured research method, and then seeking that the usage of words could not influence in how the students saw the presented people. After the material recoil, there was the dialogue to lighten who were those people, and it was introduced to them an ample panorama about what would be Science and how it is related to everyone's lives. This includes a try to deconstruct ethnic and gender stereotypes already formed, searching to encourage the continuation of studies by part of the attending students. Later, we analyzed the drawings made and the professions attributed to each one of the presented people.

The obtained results in each one of our study's steps were analyzed and compared amongst themselves, being presented and discussed in the next section.

4. Results and Discussion

Our survey about gender and ethnic representativeness in Brazilian Exact Sciences' field, in the period from 2013 to 2017, from CNPq database is presented in Figure 1.

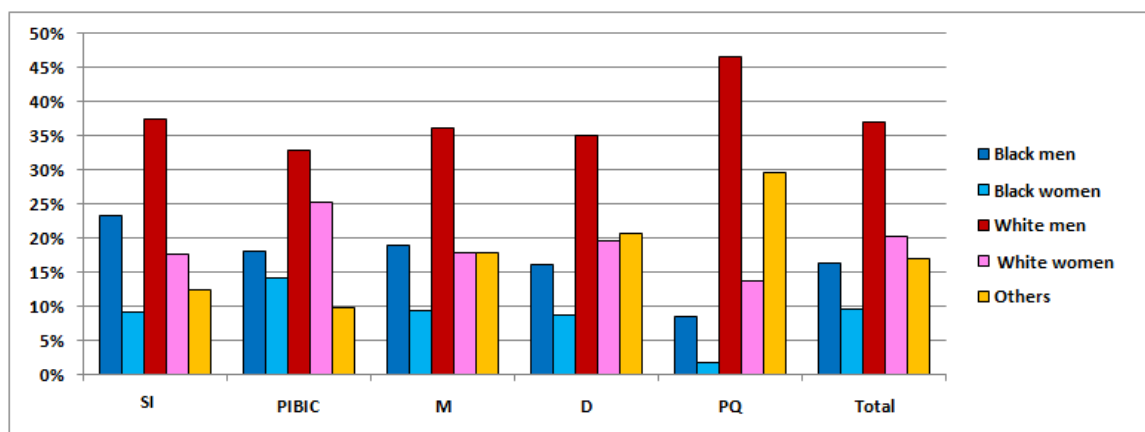


Figure 1: Distribution of researchers in the field of Exact Sciences, in the period of 2013-2017, through gender and ethnicity.

It's distributed, respectively, as Scientific Initiation (SI), Institutional Program of Scientific Initiation Fellowships (PIBIC), Master's Degree (M), Doctorate's Degree (D), Research Productivity Fellowship (PQ) and the total of all. We can observe the number of women is much smaller than men's one, since graduation (Scientific Initiation – IC) until the research scholarship (PQ). Moreover, this number goes down as women advance in career. While in the beginning, they represent about 30%, according they progress in career, they represent a little more than 12% on higher levels. If we add the ethnic profile, black women represent less than 3% of research productivity fellowship holders in this area. This shows that the leaky pipeline effect isn't associated only to gender, but furthermore to the belonging ethnicity. Such result is also observed when in the survey made within the Universities in the city of Rio de Janeiro/Metropolitan Region, which offer Physics' graduation course, as shown in figure 2. We can notice that on average the female researchers professors represent nearly 21% of the teaching body of the departments/institutes of Physics. Considering both ethnic and gender questions, UFRJ, PUC-Rio and UFRJ don't have black women professors. As for, UFF and UERJ, it wasn't possible to identify professors' ethnicity.

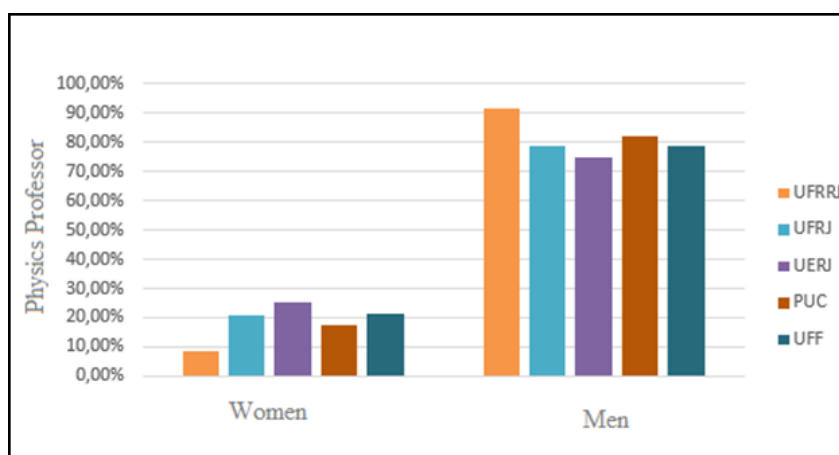


Figure 2: Physics Professor Distribution by gender at Universities in Rio de Janeiro city and metropolitan region.

These results demonstrate to be according to the scenery exposed in the survey made on CNPq database. In both analysis, female representativeness corresponds to the international average (less than 25%), demonstrating that this is not a local problem [16].

A study made by Braga and collaborators in 2015, based in ethnic information, showed that black women presence in Brazilian science, in general, also is minimum. Among 91,103 scholarship holders from CNPq attending a post-graduation course, be in form of Master, Doctorate or Scientific Initiation's degree, white women represent 59% of the total of fellowship women holders and the group of black women, 26.8%. The International fellowships generally involving technology are more excluding to women and especially to black women whom mostly didn't have access to a quality education and a second language [17]. Going against such research with our works for Exact Sciences, we observed both white and black women show up in a very much-reduced number, demonstrating that to disrupt with the gender/ethnic barriers could be even more difficult and that a more cautious

look should be given. In this way, it's important to comprehend how the scientist profession is realized by students from middle/high school, and that was the last step of this work.

When analyzing the obtained data with basics education's students from Rio de Janeiro, as result of the "Draw a Scientist Test" [18], it is observed that nearly 80% associate scientists to the white and male form. Subsequently, we sought to evaluate the obtained data through the test where students should identify the scientists and other professions among 12 shown photos, composed by men and women from different ethnicity. The number of identifications of women in the scientific career was inferior to 2%, whereas none of the black women was related to Science. It is important to point out that white women were related to professions as basics education's teachers, artist or secretary. Black women were associated to housewives or to professions like cleaners or maid employees. Black men were also frequently associated with professions of low schooling as concierge and cleaner, for times related to soccer players and where black men have representativeness in our country.

On the other hand, the larger association with science is observed in white men, and when they were associated to other professions, they always were those with prestige, like physician, lawyer, executive and politician. It's important to highlight that black ethnicity is represented by nearly 90% of the students, and women were about 60%. Students demonstrated that even belonging to minority groups, they don't recognize themselves as being part of the portion that builds science and this is related to how their groups are represented: in the disciplines they study, teachers, news on tv or social medias. The non-representativeness in university, in the encouragement of gender/ethnic representativeness in research and formation of students in the "hard" fields as Physics and Mathematics, influences on how these students construct ethnic and gender based on stereotypes. As their average ethnic and gender are in less prestigious professions, they tend to see themselves in those positions, the exception is made as in the case of soccer players, since that is a profession associated with a chance of social rising for youngsters from peripheries, as put by many students.

Data obtained with the students are very important and if we lay our eyes on researchers with productivity scholarship (PQ) from CNPq, women have a low rate of representativeness. The applied criteria to the obtaining the fellowship is the same for men and women, without caring about ethnic and gender circumstances [19]. These data are corroborated with the obtained results both in the representativeness observed within universities from Rio de Janeiro or even as high school students, which don't associate scientists belonging to their groups be in gender, ethnicity or social class. Observing the

schooling of adult people, considering color/race and gender's differences, we can say that even though there were advances conquered in the last years, with more Brazilians from both genders reaching the higher educational level, the distances between the groups remain. That's reflected in the occupation of Brazilian's classrooms, between 1995 and 2015, it doubles the white adult population with 12 years or more of studies, from 12.5% to 25.9%. In the same period, black population with 12 years or more of studies goes from the unbelievable 3.3% to 12%, a growth of almost 4 times, but that doesn't hide that the black population reaches only now to the landings of twenty years ago from white population.

Those inequalities remain and demand a wary look to the oppressions lived by black women, as observed in our work. According to the research "Gender statistics", from the Brazilian Institute of Geography and Statistics (IBGE), the percentage of white women with a complete higher education is 2.3 times bigger than the black women. Only 10.4% of black women have a complete higher education. Inequality of color or race among women can also be verified in the distribution of the occupied population by instruction level, which shows an elevated participation of black women without any instruction and incomplete basics level (42.5%) when compared to white women (28.2%). It's important to observe that those disparities are current on the extremes of distribution of the instruction levels and, in higher education case, they are even more favorable to white women (26.0%) in relation to black women (11.2%) [20].

This way, we believe to have demonstrated that we cannot consider gender questions in a lone way, but also must be taken into account the impact of the ethnic and social questions and that are directly related to the representativeness of the vulnerable groups in Exact Sciences. The best way is to consider that is still needed the implementations of affirmative actions.

5. Final Considerations and Conclusions

The results reflect clearly the actuation of the leaky pipeline effect in university women's lives that choose those hard fields of science, where we still are minority. This reflects directly in the impact of the researches made by women in exact sciences in Brazilian universities, showing they have to work in an unequal rhythm, for longer and larger amount of work, with more orienting projects in graduation level and receiving less incentives and financial aids to researches in their studies, since mostly the obtaining of resources is attached within the condition of CNPq fellowship holder and many post-graduation committees, utilize such criteria to accredit their teaching body. This is corroborated with our results and how women and black people see themselves in academy. It's made necessary

the implementation of affirmative actions' policies in Exact Sciences, considering gender and ethnicity. Those policies should consider assurances as the right to motherhood, with childcare policies and encouragement to women researchers and students, policies that consider the function of relatives' caretaker, that they stipulate a minimum of graduation scholarships to researches for women and mainly, black women. The guarantee that judgment committees, contests examining board, universities collegiate and events commissions in Exact Science have ethnic and gender equity, aiming to contribute to a larger participation of women in this research field. It's not enough a timid policy of maternity leave, since it's granted by law. They are specific question, which have as objective the appreciation and permanence of women in scientific career, so they can conciliate it to motherhood and caretaking.

Beyond that, foment agencies should also promote policies with the objective of seeking the ethnic and gender equity in distribution of resources for researches and incentive's fellowships, aiming that really could occur a change in this overview that remains as representative of a patriarchal society, even where the most important should be the scientific activity.

It's important that universities and foment agencies have as institutional schedules the encouragement for women to act in Exact Sciences, that should start yet in school with the objective that those groups see themselves represented in Exact Sciences and not only in less prestigious professions, contributing for ethnic and gender stereotypes as the ones observed in our work, don't be perpetuated.

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