Gender Inequality among Faculty at the University of Puerto Rico Río Piedras Campus – a ViDAS-VoCEA[1] Report

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Mayo 23, 2022 v1
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[1] ViDAS - **V***i*sibility driven by **D**ata-based decisions, **A**ccess and **S**ustainable Practices; VoCEA-**V**irtual **O**bservatory for **C**ulture **E**quity in **A**cademia at the University of Puerto Rico Río Piedras

"*What I have not drawn, I have not seen"*
*(*J. G. von Goethe*) [1]*

can easily be re-written into

"What I do not count, I cannot see",

to summarize the invisible barriers
faced by academic women in STEM

Since the ViDAS and VoCEA efforts started
in the fall of 2020

Licenciada Aurora Sotogras and professor Leticia Fernandez,
two-top level administrators that were consulted to identify sources of data and understand the functioning of UPRRP changed position and retired, respectively

Dr. Vilmalí López-Mejías,
A colleague, participant of this effort, and productive researcher
from the College of Natural Sciences resigned.

Dr. Olga L. Mayor-Bracero and Dr. Patricia Burrowes
Two active and productive researchers
from the College of Natural Sciences resigned and will retire, respectively

Dr. Gladys Nazario and Dr. Noemi Cintron,
Two fantastic and well-appreciated faculty
from the College of Natural Sciences retired

Dr. Ana Guadalupe
A strong researcher and visionary administrator
from the College of Natural Sciences retired

Dr. Patricia Ordoñez
An innovative and enthusiastic professor
From the College of Natural Sciences resigned

Dr. Michelle Schelske
A professor and researcher from the College of Natural sciences resigned

August 28, 2022 v2

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Executive Summary

In the fall of 2020 and for a period of almost two years, a group of mostly women professors and scientists from the colleges of Natural and Social Sciences began a series of informal discussions on gender equity and inclusion at their home institution, the University of Puerto Rico – Río Piedras Campus. Later on, in 2021, faculty from the Schools of Business Administration and Architecture joined the conversations. The short-term goal of the group was to assemble a team to work on a proposal for the NSF-Advance Program on Organization Change for Gender Equity in STEM Academic Professions[2]. The long-term goal of the group is to elicit institutional change that would improve faculty recruitment, development, and retention with a special focus on achieving equity and inclusive excellence for women faculty in STEM fields. The challenges that came along with the preparation of a preliminary proposal and the re-grouping for a new, full proposal were difficult to anticipate. Yet, multiple lessons were learned and we believe that it is important to share some of these with the broader community of our campus, the University of Puerto Rico, and other stakeholders. Our hope is that this report will spark further discussions and actions that can mitigate/reverse observed trends shown by the numbers and narratives shared with us and documented in this report.

This report is structured around six main sections. In *Section 1*, we briefly describe the challenges and professional situations experienced by women in STEM. In *Section 2*, we provide a brief description of intersectionality and its multiple dimensions, and its value to understand inequities in STEM. In *Section 3*, we highlight a number of characteristics of the University of Puerto Rico Rio Piedras campus with a special emphasis on STEM. In *Section 4*, we focus on the two complimentary approaches that we used to provide-evidence based support for gender equity and inclusion problems at UPRRP. The analysis of institutional data focused on tenure-track and tenured faculty. In *Section 5*, we outline a proposed conceptual model geared towards a path for sustainable change regarding equity and diversity, and describe possible drivers behind the observed problems. Finally, in *Section 6* we recommend a multi-dimensional and multi-scale strategy for the sustainable participation of academic women in STEM at UPRRP.

Main findings:

- Diversity reflected by country of birth is not associated with diversity in gender. The College of Natural Sciences (CNS) is very diverse in terms of nationalities yet very little diverse gender-wise. The opposite is true in the College of Social Sciences (CSS).

- In the College of Natural Sciences, the percentage of men and women in tenure track and tenured positions is 70% and 30%, respectively.

- At the campus level, men outnumbered women (mean: 79% men and 21% women) in all but

[2] The NSF definition of STEM includes mathematics, natural sciences, engineering, computer and information sciences, and the social and behavioral sciences – psychology, economics, sociology, and political science

one (15-25 yrs.) in the five service-time categories.

- The academic population or the faculty service-time pyramid has an inverted shape; in demography or population ecology such pattern indicates a troubled population or in sustainability, an unmanaged, high-risk "de-growth" process.

- Faculty in academic management or service positions include both administrative and teaching faculty; more women than men serve the university in academic management appointments (38% vs. 22%) which can reduce their research and other academic contributions.; also, more women than men hold administrative faculty positions (39% vs. 9%). A large proportion of these women are in the Deanships of Academic (DAA) and Student (DAE) Affairs.

- Among teaching faculty with tenure-track and tenured positions the ratio between men and women varies among units; in the CNS this ratio is >1.

- Women with ≥15 yrs. of service are highly represented in academic management positions. In contrast, men with ≥25 yrs. and <15 yrs. of service are highly represented among teaching tenure-track and tenured faculty. The situation is dire within the CNS where men outnumber women in all service year categories, particularly ≥25 yrs. of service.

- Data from 2016 showed that the mean number of substitute FTEs for research varied greatly among academic units (mean ± standard deviation; 0 and 4.2 ± 3.5); within the CNS men had on average more teaching release-time than women (4.2 ± 3.4 vs. 2.3 ± 3.1).

- The mean number of compensation FTEs varied greatly across the campus (0 to 2.5 ± 4.9); within the CNS they were similar for men and women (2.1 ± 3.0 vs. 1.8 ± 2.9), yet we do not know if there are differences in the type of work compensated (i.e. research vs. service).

- Additional salary tied to grants heavily favors men.

- Men submitted more proposals for external funding than women (191 vs. 143) in the period 2018-2020.

- We observed a significant association between gender, proposal category and status: women were more successful at getting service proposals funded whereas men were more successful with research and training proposals.

- Results indicate that 1,413 out of 4,995 publications (~30%) had a woman author/co-author; yet, we do not know if the work was generated at UPRRP or by women collaborators from other institutions.

- About 30% ($n = 27$) of all UPR patents were generated by faculty affiliated to UPRRP; of these, only two were generated by inventors who are women; both inventions occurred at the Molecular Sciences Research Center.

- Women faculty and graduate students experience a moderate to high occurrence of instances of

microaggressions and a high occurrence, respectively.

- We observed a *siloed institutional data culture* in which data is not made available, metadata is deficient, and personnel cannot clarify information contained in the databases.

Acknowledgments

Our efforts benefited through interactions with faculty, university administrators, staff, and graduate students. We are grateful to Valerie Ascencio Torres, Nestor Carballeira, Liz Diaz Vazquez, Leticia Fernandez, Sandra Flores, Edith Gonzalez, Carlos Gonzalez, Ana Guadalupe, Rebeca Guadalupe, Mayra Jimenez Montano, Jamiesselle Maldonado, Liz Santiago Martoral, Gabriela Medina, Isabel Montañez, Sonia I. Ortiz Robles, Yakshi Ortiz, José Pabon, Carmen Pacheco Sepulveda, Luis R. Pericchi, Idalia Ramos, Gabriela Rebollo Becerra, Yashica Reyes Marrero, Basilio Rivera, Zulyn Rodriguez, Aurora Sotogras, and DEGI personnel who in various capacities contributed to this effort.

Introduction

In the fall of 2020 a group of women professors and scientists from the Colleges of Natural and Social Sciences, began a series of informal discussions on gender equity and inclusion at their home institution, the University of Puerto Rico – Río Piedras Campus. New participants from the Schools of Business Administration and Architecture joined the initiative a year later. The short-term goal of this group was to assemble a team to work on a proposal for the NSF-Advance[3] program on Organization Change for Gender Equity in STEM Academic Professions[4]. The NSF Advance program emphasized 1) an evidenced-based approach to identify systemic gender inequities and propose strategies to solve/mitigate them, and 2) the use of "intersectional approaches in the design of systemic change strategies for STEM faculty in recognition that gender, race and ethnicity do not exist in isolation from each other and from other categories of social identity." The group opted to work on an Institutional Transformation-IT track[5] that required the preparation of a preliminary proposal (9 pages; due and submitted on April 22 of 2021). In a second effort, the enlarged group focused on a Catalyst Proposal (15 pages; submitted in January of 2022). The challenges that came along with the preparation of the preliminary proposal were difficult to anticipate. Yet, multiple lessons were learned and we believe that it is important to share some of these with the broader community of our campus, the University of Puerto Rico, and other stakeholders. Our hope is that this report will spark further discussions and actions that can mitigate/reverse observed trends shown by the numbers and narratives shared with us and documented in this report.

We organize this report into seven sections. In *Section 1* we briefly describe the challenges and professional situations experienced by women in STEM. In *Section 2* we provide a brief description of intersectionality and its multiple dimensions, and its value to understand inequities in STEM. In *Section 3* we highlight a number of characteristics of the University of Puerto Rico Rio Piedras campus with a special emphasis on STEM. In *Section 4* we focus on the two complimentary approaches that we used to provide-evidence based support for gender equity and inclusion problems at UPRRP: Analysis of existing data and development of a Pilot project aimed at documenting microaggressions and sexual harassment experienced by faculty and graduate students; this section includes Methods and Results. In *Section 5* we outline a conceptual model that can provide a path for sustainable change regarding equity and diversity, and describe possible drivers behind the observed problems. Finally, in *Section 6* we propose a multi-dimensional and multi-scale strategy for the sustainable participation of academic women in STEM at UPRRP. Overall, our report provides a radiography of actions that should take place to promote an equitable and diverse STEM, and more broadly speaking academic community. Moreover, we aspire that the findings reported within this report will serve as a roadmap for novel and effective solutions for enhancing inclusion and empowerment of STEM women in the advancement of our institution to the 21st century.

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[3] NSF-Advance (https://beta.nsf.gov/funding/opportunities/advance-organizational-change-gender-equity-stem-academic-professions-advance)

[4] STEM in NSF includes mathematics, natural sciences, engineering, computer and information sciences, and the social and behavioral sciences – psychology, economics, sociology, and political science

[5] The IT track "is designed to support the development, implementation, and evaluation of *innovative* systemic change strategies that promote gender equity for STEM faculty within an institution of higher education

1 Representation of women in STEM

Women are both *engines* and *beneficiaries* of an ongoing economic and societal paradigm shift intricately tied to the production and use of knowledge [2-5] and global changes [6,7]. Formally referred to as a Knowledge-based Economy/Society (KBE/KBS), this paradigm shift strongly relies on human capital, science, technology, and innovation (STI) for the production of goods and services [8]. Since a KBE/KBS relies on the production of knowledge, this socio-economical approach directly impacts the academic world [9-11], and more specifically gender relations and equity [2,12,13]. Although an increasing number of studies demonstrates the unique ways in which women contribute to STI [4,14,15], complex mechanisms and processes operating at a variety of scales continue to limit their participation in academia as shown by regional and national initiatives [16-18].

Academic women faculty and students are commonly the minority in STEM departments. For example, a 2014 report showed that 36 percent of STEM PhD recipients were women but that they only made 18 percent of full professors in science and engineering [19]. To counteract these findings, establishment of collaborative decision-making within departments further facilitates equity, as evidence shows that less hierarchical workplaces foster transparency and inclusion. Efforts to understand the lack of participation of women scientists in research endeavors have identified major challenges that include but are not limited to 1) ineffective mentoring, 2) lack of networking opportunities, 3) disparities in research support, 4) negative stereotypes about women, 5) microaggressions, 6) lack of training in critical professional skills, and 7) less satisfaction with their professional life.

1) The lack of effective mentoring persists as an important factor in the relative deficiency of professional success of women PhDs who pursue academic careers [20]. Common barriers confronted by females in the STEM fields can be mitigated through positive mentoring relationships [21]. For women in STEM careers, mentoring has been shown to increase self-confidence and enhance communication skills. Mentoring relationships also provide role models and present opportunities to discuss balancing professional and personal responsibilities [21]. A mentor is meant to embody wisdom and to serve as teacher, protector, and counselor throughout the different stages of the professional career path. Several studies demonstrate that mentorship can be the single most influential way to support the successful development and retention of women STEM faculty. Evidence showed that in a time of dwindling resources and fiscal crisis for our institution, structured mentoring efforts benefit faculty, students and the university community. It is a win–win situation.

2) Previous research revealed that women faculty in traditional STEM departments face fewer resources for collaborative research and more limited career opportunities than their men counterparts [22]. Women in STEM may be excluded from informal networks, experiencing isolation and difficulty locating mentors. Building inclusive communities in which faculty form connections and acquire tacit knowledge to navigate academic life is critical for the retention of women faculty members.

3) Negative stereotypes also hinder the development of STEM women. Gunderson et al. 2011 [23] report how negative stereotypes about women's math abilities are transmitted to girls by

their parents and teachers, shaping girls' math attitudes and ultimately undermining performance and interest in STEM fields. In fact, recent research evidenced how as early as six years old girls may be impacted by gender related stereotypes and how this may affect their professional aspirations later in life [24,25]. With regards to STEM academic women faculty, data shows that women STEM will do more teaching and service than men [26,27]. Moreover, more female than male STEM associate professors reported having to work harder than their colleagues to be recognized as legitimate scholars and scientists. Women faculty members in STEM have been less likely than male faculty members to feel welcome in higher education institutions.

4) Research demonstrates that STEM departments are different from non-STEM departments in terms of organizational demographics and the incidence of gender role stereotypes. Moreover, STEM disciplines see men (more than women) as disciplinary experts [28-30]. Minority status and stereotypes associating scientific expertise with maleness contribute to an unsupportive climate for women faculty. In addition, this hostile environment unfortunately yields a decrease in professional satisfaction among academic women which results in an increase in attrition relative to male colleagues [31-35]. Experiencing negative department climate predicted high attrition for women compared to men, despite being equally committed to their professional career [32,35-38]. Evidence suggests that although achieving critical mass of academic women in the workplace may begin to reduce gender inequities, it also might elicit resistance from the majority group members who may anticipate losing status and resources [26,39]. Thus, increasing the proportion of academic women in a department does not necessarily solve problems encountered by women who are a minority group in academia [40]. Previous results on faculty satisfaction in other institutions showed that women faculty were more dissatisfied than male faculty with their professional relationships and reported more exclusion from informal networks [41].

5) Subtle discrimination in the form of insults and disrespectful communication that occur on everyday exchanges, i.e., microaggressions, negatively affects the psychological and behavioral health, and careers of STEM women [42,43]. These verbal and/or non-verbal exchanges convey messages that fall into six dimensions: sexually objectifying women, second class citizen, assumptions of inferiority, denial of the reality of sexism, assumptions of traditional gender roles, and use of sexist language [43]. In one study STEM women regardless of rank, experienced gendered microaggressions in their daily work environments. Additionally, racial microaggresions have a negative effect on the level of persistence in STEM careers for Latina women [44].

6) At the same time that higher education institutions face a STEM gender gap, major efforts are required to develop a workforce with the skills needed for the future. STEM skills programs provide access to professional development initiatives that can empower women in STEM to achieve their career goals. By providing women in STEM with opportunities to learn new skills, universities can help women in STEM be more successful in their careers, and potentially increase their job satisfaction. Offering skills training also opens the door for more women to advance into leadership positions. The majority of women in STEM value

skills training as a way to move into a new role or advance in their career. While the will to learn new skills is there, the access to these opportunities is very difficult to accomplish for women in STEM. Overall, they face multiple barriers for taking advantage of opportunities to learn new skills. The lack of time and inflexible schedules and other non-professional responsibilities are the main barriers reported. In particular, the lack of time is by far the biggest barrier to taking advantage of skills opportunities for women in STEM.

7) Studies also demonstrate that academic women in STEM manage to feel significantly less satisfied with their professional life than their male colleagues [32,35,45-47]. Gaining tenure in an academic position is seen as an indicator of success and prestige and most often contributes to overall job satisfaction. Researchers found that approximately 50% of faculty reported substantial stress in trying to balance the needs and duties of personal/family life with professional work, and women faculty report more obstacles in moving up the tenure ladder, in part due to work-family balance [48]. Evidence related to the value of the institutional environment indicates that women faculty report higher satisfaction when they feel a sense of community, support, and control. While perceptions of health and retirement benefits and campus facilities were indeed important to satisfaction, the impact of department fit, recognition, balance and mentoring appear to be most important to satisfaction, and particularly so for women.

2 Intersectionality -

Intersectional theory proposes that gender intersects with statuses like race, ethnicity, nationality, class, sexuality, disability, and age to affect people's lived experiences, including experiences in academic settings [49,50]. For example, young women in STEM in particular are interested in learning new skills for advancing their career path, with 65% of those under 35 saying they value it for getting a new job or promotion, compared with 59% of women 35 to 54, and 41% of women 55 and older. These data suggest that age and gender in women in STEM coalesce in the decisions they make to achieve important professional milestones. Similarly, race may intersect with gender to produce the double bind effect in which both factors influence the career paths of women in STEM [51,52]. For example, research from an intersectional lens as it relates to STEM in higher education alert regarding retention not only for women, but especially for those from underrepresente groups, especially African Americans and Latinex [53]. As McGee [54] suggests, racialized structures within STEM disciplines reinforce discriminatory practices that include but are not limited to the distribution of available resources.

3 The University of Puerto Rico at Río Piedras

The UPRRP is the oldest (establishment in 1903), largest (10,877 undergraduate and 3,015 graduate students), and most complex (74 BS, 46 MS, and 14 PhD programs) campus of the University of Puerto Rico (UPR) public higher education system. As the only Doctoral-R2 institution on the Island [55], UPRRP contributes to the formation of human capital at multiple levels. At the graduate level, UPRRP (period of 2015-2020) granted a total of 453 doctoral and 1764 master degrees; the College of Natural Sciences (CNS) that concentrates the largest number of STEM disciplines granted 132 doctoral (76 men and 56 women) and 199 master (113 men and 86 women) degrees during the same period [56]. A number of NSF-funded initiatives are led by

PIs at UPRRP, including The Luquillo Long-Term Ecological Program, training programs (LSAMP, REU), and Centers (CREST-PRCEN, CREST-CiRE2N, PREMs). UPRRP maintains close ties with UPR's Medical Campus (MSC) and the Molecular Sciences Research Center (MSRC); many of these initiatives have thrived to "gender" parity in their programs but this has not manifested at the campus level.

Nationwide, UPRRP is a unique and highly competitive Hispanic serving institution, that ranked third among Hispanic serving institutions (2014-2015) conferring doctoral degrees to Hispanic students [57]. At the undergraduate level, UPRRP (period 2013-2017) was the second largest contributor of Hispanic/Latino students that earned a doctoral degree nationwide [58]. UPRRP attracts graduate students from Latin America and the Caribbean, furthering its academic and research influence within and outside the island.

Academic women in STEM at UPRRP navigate a dual status of intersectionality [49,59] when comparing the barriers that they face during their professional interactions. At the local level, Latinex Faculty in STEM are part of the cultural majority in the Island, but women faculty face gender disparities [60-62]. In contrast, when inserted in a global world, these same academic women face, not only gender disparities but also other cultural discriminatory barriers when they aim to achieve career successful outcomes. Additional "local" barriers for women in STEM on our campus may stem from place of birth (women - irrespective of ethnicity - not born in Puerto Rico; Figure 1) and/or place of training (higher education degrees earned outside Puerto Rico). Thus, addressing intersectionality issues can provide, insightful, and unifying operational framework to empower changes in institutional culture and as a consequence, may produce policy changes.

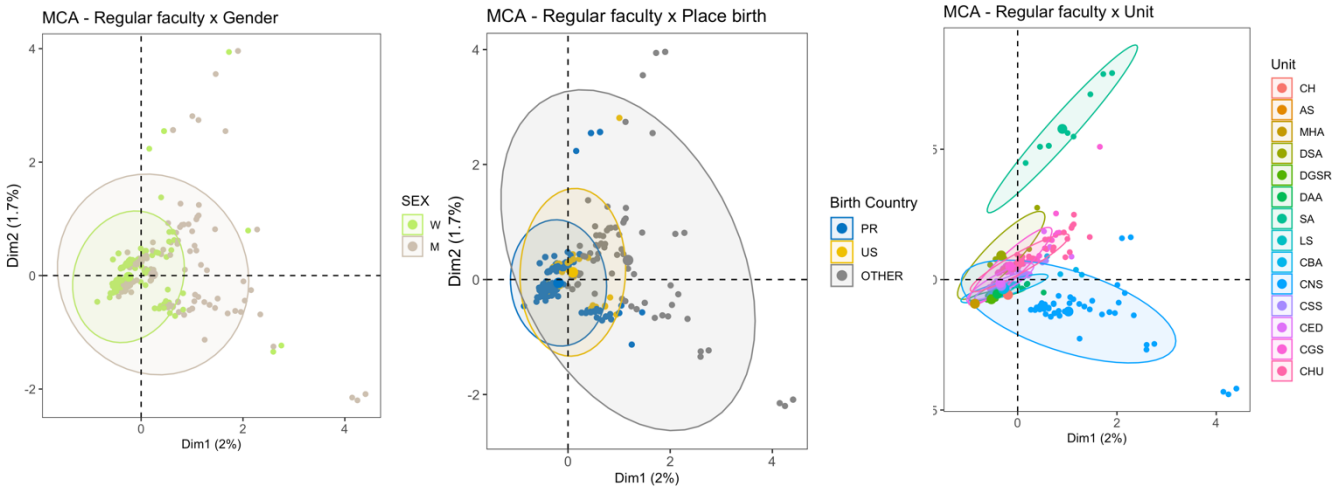

Figure 1. Variation among faculty at UPRRP based on gender, place of birth, and unit. These biplots show results of a Multiple Correspondence Analysis (MCA): each point represents a tenure-track or tenured faculty whereas the ellipses 95% confidence intervals based on sex (left), place of birth (middle), and main academic unit (right). This MCA showed that the vast majority of faculty at UPRRP were born in Puerto Rico followed by the US, and other places, diversity reflected by country of birth is not associate with diversity in sex. Specifically, the College of Natural Sciences was the most diverse faculty based on place of birth but the least diverse one in terms of sex. The opposite was true for other colleges, e.g., College of Social Sciences, that had a similar number of men and women, but little diversity based on place of birth.

4 Status of women faculty at UPRRP

We used two complimentary approaches to provide-evidence based support for gender equity and inclusion problems at UPRRP (CIPSHI protocol 2021-085). First, we guided our initial effort using used Frehill's ADVANCE Indicators Toolkit[6] [Questions 1-4; 63] and a Theory of Change approach [16,64,65] to link problems with drivers. This latter step is important to design strategies aimed at transforming and promoting the advancement of women in STEM at UPRRP. We focused on tenure-track/tenured faculty due to the scope of the NSF ADVANCE initiative. Second, we developed a pilot project aimed at documenting microaggressions and sexual harassment experienced by faculty and graduate students.

4.1 Methods

Characterizing the status of women faculty at UPRRP involved 1) meetings with high- (Deans), middle- (Associate and Auxiliary Deans), and low- (Program Coordinators and Departmental Chairs) level administrators (Appendix 1), 2) submission of formal requests of information to them (Appendix 2), 3) obtaining approval by the Institutional Review Board Committee (IRB), and 4) data exploration, analysis, and interpretation. We received a roster file (August - December 2020; Human Resources-HR), a file with submitted/awarded proposals (2018-2020; Deanship of Graduate Studies and Research-DGSR), and a file with formal complaints made to Title IX (Office of Compliance and Audit) (Appendix 3). Overall, the files lack metadata, the data had errors and/or was not homogenized, and eliciting cooperation from the providers of information either through e-mail or phone was very difficult. We also realized that critical fields were missing altogether, for example, the usual institutional categories that describe administrative levels (coordinator, director, dean, and so on), and that protocols to protect data privacy and confidentiality [66] were absent which led the institution to simply limit the access to data. At the same time, these "counting" mishaps helped us identify initiatives that would effect change around open data standards that call for inclusion, openness, transparency, and reproducibility while protecting sensible information [67]. Finally, we use R software to conduct exploratory data analysis (EDA), data analysis and visualization [68].

A roster file from August to December 2020 provided by the Deanship of Administration, a list of proposals processed between 2018-2020 provided by the Deanship of Graduate Studies and Research, historical FTE files from 2016, and Web of Science became our main sources of institutional data. The historical FTE files were the most difficult to use, largely in part because faculty were not labelled by employee type (regular) and the turnover has been very high since then. Nevertheless, we think that this data is valuable as a way to understand resources available to faculty in a research institution.

A pilot study led by two of us (YR and ES) will provide unique data on the workplace environment from the lived experiences of women faculty and graduate student at our institution (Appendix 4). This study focuses on microaggressions *[69]* and sexual harassment [70]. The general objective of this study was to explore the mediating effect of bullying, harassment, microaggressions and gender bias in the exercise of academic citizenship of faculty and graduate students. In a first step, we used a mixed sequential design to collect quantitative data. In a second step, we used focal group interviews to obtain qualitative data. Briefly, we used an online

[6] The four group of questions broadly pertain to 1) Distribution of STEM faculty by gender, rank, and department, 2) outcomes of promotion and tenure by gender and department, 3) leadership and gender, and 4) allocation of resources/scholarship.

questionnaire that included two instruments: the Female Microaggression Scale (FeMS) [69] and the University Sexual Harassment and Social Interaction of Sexual Content Scale (EASIS-U) [70]. The FeMS includes 34 instances of microaggressions classified into eight dimensions (assumptions of traditional gender roles, sexist language, implicit threatened physical safety, explicit threatened physical safety, invalidation of the reality of sexism, assumptions of inferiority/second-class citizen, environmental, sexual objectification), and yields scores for each dimension, as well as a general score. The EASIS-U includes 38 items grouped into four groups (behaviors of sexual blackmail, sexual harassment with a verbal component, physical component sexual harassment, and social interaction of sexual content that they have place in the university setting).

4.2 Findings

We organize this section around general findings, evidence obtained to address Frehill's[5] broad set of questions, and preliminary results of pilot study on microaggressions. Key findings are in **bold**.

General findings - Identifying and obtaining the data to provide-evidence based support for gender equity problems was challenging. First, we discovered a "*siloed institutional data culture*" [71] that served the administration needs, e.g., budgeting, accounting, planning, and reporting, but that limited the access and use of data by other stakeholders that like us may want to address and/or discover institutional problems. Second, the "*hierarchical organization structure*" [72] of UPRRP does not promote cross-scale communication. At the same time the aforementioned challenges led to the identification of new initiatives that could help effect transformative institutional change through the use of open data standards that call for inclusion, openness, transparency, and reproducibility while protecting sensitive information [67].

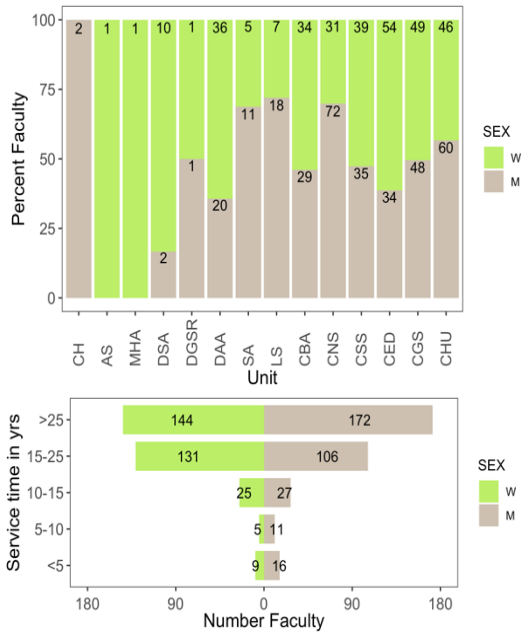

Figure 2. a) Distribution of regular faculty by administrative/academic unit and b) service time. Service time categories derived from hiring date. CH: Chancellor Office, AS: Academic Senate, MHA: Museo de Historia, Antropología, y Arte, DSA: Deanship of Student Affairs, DGSR: Deanship of Graduate Studies and Research, DAA; Deanship of Academic Affairs, SA: school of Architecture, LS: Law School, CBA: College of Bellas Artes and Oficios, CNS: College of Natural Sciences, CSS: College of Social Sciences, CED: College of Education, CGS: College of General Sciences, CHU: College of Humanities.

Faculty Composition (Q1) – As of December 2020 there were 646 regular, i.e., tenure-track and tenured, faculty at UPRRP; of these 314 were women and 332 men. STEM faculty is distributed in different academic units but they could not be identified based on the data; thus, we stratified faculty by main administrative/academic units. The College of Natural Sciences (CNS) concentrates most STEM faculty and research activity. *Finding 1* – **In the CNS the percentage of men and women in tenure track and tenured positions is 70% and 30%, respectively** (Figure 2a). This figure hides larger sex differences in Physics, Mathematics, and

Computer Science (mean: 84% men and 16% women). Significant gender differences were also observed in the Schools of Architecture (SA) and Law (LS), and the College of Humanities (CHU). In contrast, the Colleges of Social Sciences (CSS) and Education CED) were close to gender parity based on only numbers (Figure 2a).

Faculty Dynamics (Q2) – Academic service time was used to indirectly understand faculty dynamics. *Finding 2* - **Men outnumbered women** (mean: 79% men and 21% women) **in all but one (15-25 yrs.) of the five service time categories** (Figure 2b). Finding 3 – **The population of faculty members or academic service-time gender pyramid has an inverted shape**; in demography or population ecology such pattern indicates a troubled population or in sustainability, an unmanaged, high-risk "de-growth" process (Figure 2b).

Function (Q3) – Faculty are classified by a number of variables. We used employee category [teaching (*n*=542), research (*n*=6), and administrative (*n*=98) faculty; research and teaching were merged] and appointment type (tenure track and tenured positions, and *trust appointments or "puestos de confianza"* to learn about roles that women and men faculty engage at UPRRP. Teaching faculty receive variable amounts of teaching release-time to conduct research, creative projects, and administrative work (see *Resources*). *Trust appointments* represent leadership academic management appointments that change with each elected chancellor. *Finding 4* – Faculty in academic management positions include both administrative and teaching faculty; **more women than men are in academic management appointments (38% vs. 22%); also, more women than men hold administrative faculty positions (39% vs. 9%).** A large proportion of these women are in the Deanships of Academic (DAA) and Student (DAE) Affairs **(**Figure 3a**).** Finding 5 **- Among teaching faculty with tenure-track and tenured positions the ratio between men and women varies among units; in the CNS this ratio is >1 (**Figure 3a**).** Finding 6 **- Women with ≥15 yrs. of service are highly represented in academic management positions** (Figure 3b). In contrast**, men with ≥25 yrs. and <15 yrs. of service are highly represented among teaching tenure-track and tenured faculty (**Figure 3b). **The situation is dire within the CNS where men outnumber women in all service year categories, particularly ≥25 yrs. of service** (Figure 3c).

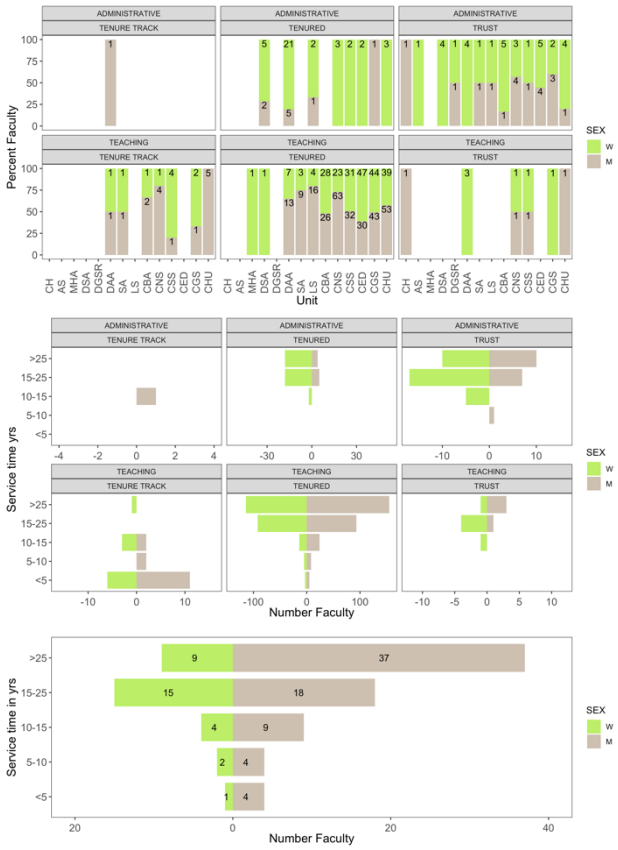

Figure 3. Distribution of regular faculty by a) administrative/academic unit, employee category and appointment type, and category and appointment type and b) service time. c) Distribution of regular faculty by service time in the College of Natural Sciences (CNS).

Resources (Q4) – Salaries, institutional funds, including start-up packages, space, and teaching release-time are resources that serve to advance faculty careers. Allocation of the 12 full-time equivalencies (FTE) includes substitution (teaching release-time) or addition (*work compensation*) of time to carry out diverse activities; *work compensation* carries a monetary disbursement for additional academic activities. Salaries at UPR are flat within academic rank. The largest variation in salary, however, is tied to discipline. Faculty serving in professional schools (Law, Planning, and Architecture) earn on average $20,000 more than those serving other academic units. Because of this salary structure we did not expect to find differences between women and men once adjusted by academic rank and academic unit. Three additional mechanisms, however, may introduce salary differences between men and women: *work compensation*, grants, and *bonuses*; the latter mechanism is available only to faculty in academic management positions. Finding 7 – An FTE report from 2016 showed that **the mean number of substitute FTEs for research varied greatly among academic units (mean ± standard deviation; 0 and 4.2 ± 3.5); within the CNS men had on average more teaching release-time than women (4.2 ± 3.4 vs. 2.3 ± 3.1**). Finding 8 – **The mean number of compensation FTEs varied greatly across the campus (0 to 2.5 ± 4.9); within the CNS they were similar for men and women (2.1 ± 3.0 vs. 1.8 ± 2.9), yet we do not know if there are differences in the type of work compensated.** Finding 9 – **Additional salary tied to grants heavily favors men (**see *Scholarship, Service, and Outreach* section). Little data is available to examine start-up packages or the space offered to newly recruited faculty.

Scholarship, *Service, and Outreach* – We examined three tangible dimensions of scholarship, namely grant, publication, and patent records. Proposal category (research, service, training, other) and status (pending, rejected, funded) were used to examine participation (2018-2020) of men and women in grant preparation (Figure 4). Finding 10 - **Men submitted more proposals than women (191 vs. 143).** Finding 11 – We observed a significant association between gender, proposal category and status**: women were more successful at getting service proposals funded whereas men were more successful with research and training proposals.** We used the Web of Science (1983-2021) to evaluate the publication record of faculty employing a big data approach to assign the sex of any author that included "University of Puerto Rico Rio Piedras" in the address. Finding 12 - Results indicate that **1,413 out of 4,995 publications (~30%) had a woman author/co-author;** yet, we do not know if the work was generated at UPRRP or by collaborators from other institutions. Finding 13 – About 30% (*n*=27) of all UPR patents were generated by faculty affiliated to UPRRP; of these, only two were generated by women inventors; both inventions occurred at the MSRC. Service and outreach are two intangible outputs that also reflect the

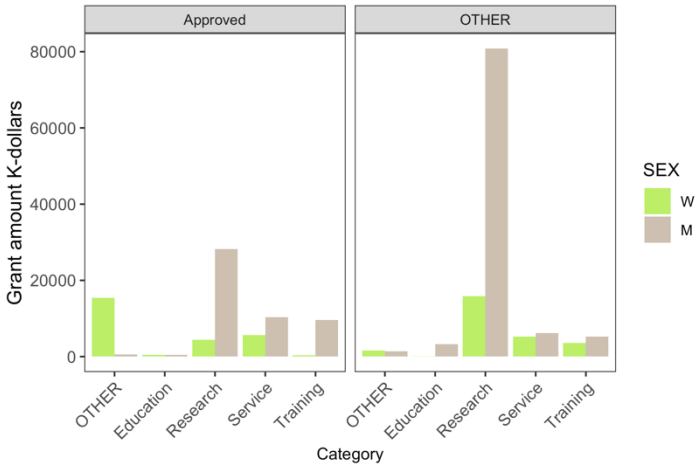

Figure 4. Funded proposals (2018-2020) at UPRRP as a function of sex and type of proposal. On the left were proposals approved at the time that the data was shared, and on the right proposals that were submitted or were pending.

academic activity of faculty and there is a large variation among academic units in how these intangibles are recognized and valued for tenure and promotion.

Workplace Environment – Past and recent informal conversations with colleagues and students have catalyzed our effort in important ways. Almost invariably, our women colleagues refer to an unfair distribution of academic burdens (e.g., service, teaching-release time), (micro)aggressions by colleagues and students, lack of appreciation of their work, feelings and acts of exclusion, little support from the institution to make their work visible through social media, including the institutional web page among others. The current fiscal and health crisis has accentuated the discomfort among our colleagues, with several reporting heightened levels of stress, plans for retiring, or plans for seeking other job prospects (one of the original contributors to this proposal leaving UPRRP effective December 31 of this year). A very limited number of initiatives have taken place to assess the workplace climate. These include a Faculty Job Satisfaction and Perception of the Workplace Environment Survey conducted campus-wide 13 years ago [73] and one conducted at the College of Business Administration (CBA) four years ago (CBA) [74], and two Student Climate Surveys conducted 13 years ago [73]. None of these surveys differentiated between women and men. The CBA report indicates that the faculty was dissatisfied with governance decision-making, college administration, salaries, and promotion opportunities.

In contrast, we know more about crimes and offenses that are monitored due to existing laws and regulations. During the period 2017-2019, the Division of Security and Risk Management (DSMR) reported crimes against individuals and property (41), car theft (1), lewd acts (1), and theft (2) [Jeanny Clery Act; 75] without discriminating by sex nor status of the victim. On the other hand, between 2016-2020 the Office of Compliance and Audit (OPA) reported 141 complaints on job harassment (1), sex/gender discrimination (6), sexual harassment/aggression/stalking (98), and domestic/couple violence (21). Of the 141 complaints the vast majority came from women (13 faculty, 20 staff, 83 students). Two members of our team that are heavily involved in education and prevention of gender violence, including sexual harassment and stalking, understand that the aforementioned figures grossly underestimate this component of the campus environment, as it has been evidenced in the broader literature, especially when in comes to Latinxs [76,77].

Microaggressions – The total FeMS score among faculty (83.56 ± 20.52; mean ± standard deviation) and among graduate students (94.27 ±21.39; mean ± standard deviation). Finding 14 – **these numbers suggest a moderate to high occurrence of instances of microaggressions in the former and a high occurrence in the latter** (Table 1). Both groups present moderate to high averages for the following subscales: invalidation of the reality of sexism,

Table 1. FeMS Means and Standard Deviations for faculty (n = 18) and student (n = 29) women at UPRRP

	Faculty		Students	
	Mean	SD	Mean	SD
Traditional Gender Roles	10.28	3.61	11.97	3.34
Sexist Language	5.50	1.76	8.00	3.48
Invalidation of the Reality of Sexism	**13.78**	4.02	**14.79**	3.86
Environmental	**12.44**	2.81	**13.21**	2.62
Implicit Threatened Physical Safety	**11.44**	3.55	**13.21**	3.34
Explicit Threatened Physical Safety	9.11	2.76	10.10	3.15
Assumptions of Inferiority / Second Class	10.28	3.82	11.17	4.16
Sexual Objectification	10.72	2.70	11.83	3.19
Total	**83.56**	**20.53**	**94.28**	**21.39**

environmental, and implicit threatened physical safety; and a low mean for sexist language (Table 1).

We examined pair-wise correlations among the FeMS dimensions (Table 2). High significant ($p < 0.01$) and positive correlations are found for faculty on the subscale of traditional gender roles with invalidation of reality of sexism ($r_s = 0.731$environmental ($r_s = 0.745$), implicit threatened physical safety ($r_s = 0.738$), and explicit threatened physical safety ($r_s = 0.758$), and assumptions of inferiority/second class citizen ($r_s = 0.737$). Furthermore, the explicit threatened physical safety factor obtained high and positive correlations with sexist language ($r_s = 0.745$and invalidation of the reality of sexism ($r_s = 0.773$). Among graduate students the correlations were slightly different: traditional gender roles did not correlate as high with the other dimensions and sexual objectification, and sexual objectification either.

Table 2. Score Spearmen correlations among the eight FeMS dimensions. **correlations significant at the 0.01 level (2-tailed); *correlations significant at the 0.05 level (2-tailed). In grey xxxxxx

		FeMS dimensions													
		Faculty (n = 18)							Graduate students (n =)						
FeMS dimensions		1	2	3	4	5	6	7	1	2	3	4	5	6	7
Traditional Gender Roles	1														
Sexist Language	2	.644**							.475**						
Invalidation of the Reality of Sexism	3	.731**	.676**						.497**	.571**					
Environmental	4	.745**	0.345	0.417					.661**	.748**	.738**				
Implicit Threatened Physical Safety	5	.738**	.482*	0.423	.570*				.371*	0.233	.454*	.393*			
Explicit Threatened Physical Safety	6	.758**	.745**	.773**	.507*	.621**			.677**	.573**	.734**	.775**	0.297		
Assumptions of Inferiority / Second Class Citizen	7	.737**	.529*	.546*	.549*	.507*	.598**		.637**	.657**	.571**	.745**	0.33	.647**	
Sexual Objectification	8	.470*	.631**	0.317	0.37	.476*	.628**	.734**	.568**	.379*	.545**	.550**	.456*	.671**	.406*

5 Systemic drivers of gender inequities and strategies for overcoming them

We put forward a conceptual model that makes use of Sustainability principles [78] to explicitly recognize dimensions (social, economic, and environmental) underlying women needs and wellbeing, and Hierarchy theory [79,80] to understand the multiple scales of interactions that mediate their participation in academia; this multiplicity of scales acknowledges the possibility for small scale processes to influence large-scale ones (bottom-up) and for large-scale processes to constrain those occurring at small scales (top-down) (Figure 5a). Furthermore we pose that laying down a sustainable pathway for the full participation of academic women in STEM-related fields involves the concept of Academic Citizenship that involve recognition, membership, and belonging [12] (Figure 5b). The three dimensions in Figure 5a capture sets of problems described as "fix the numbers" (gender equity), "fix the institution" (workplace environment), and "fix the knowledge" (excellence in science and technology) [81], while linking the complex nature of the systems in which academic women operate, largely related to interactions taking place within and across scales [12].We organize this section providing first an overview of systemic drivers, and then using these three dimensions, namely equity, economic, and workplace environment to begin to understand specifics.

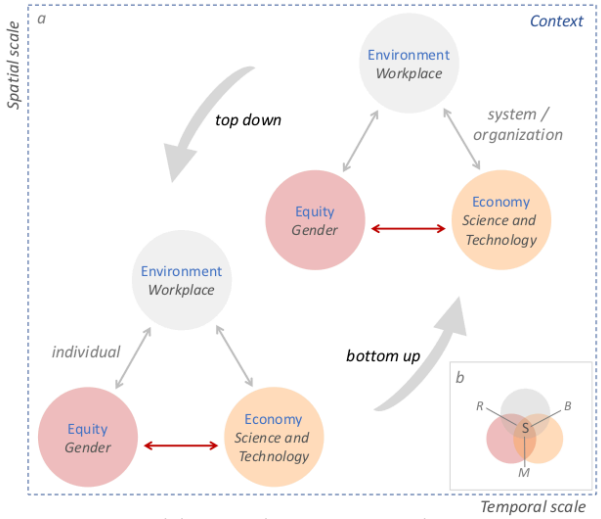

Figure 5. Stommel diagrams depict patterns and processes observable at different scales, interactions between scales, and speed of underlying processes. a) The participation of academic women in STEM has multiple dimensions. The social dimension - gender equity - relates to the opportunities available to women, and fairness principles in the distribution of academic benefits and burdens. The economic dimension relates to tangible/intangible contributions of women to STEM and the formal/informal structures that support their productivity. The environmental dimension relates to the workplace environment, i.e., physical/safety conditions, social interactions/atmosphere, support/recognition, processes/procedures, experimented by women as part of their academic lives. b) The sustainable participation of women in STEM requires overlap among the three dimensions and full academic citizenship (R: recognition, M: membership, and B: belonging). For reasons of space we only depicted two scales.

Overview of the Systemic Drivers - The drivers behind the problems that were discussed are complex in four ways. *First*, they touch multiple dimensions (workplace environment, professional opportunities, and equity) of the lives of women in STEM. *Second*, they involve informal and formal organizational structures operating at different scales: interaction with peers, departmental chairs and university officials, and the professional communities that women participate in. Whereas socially constructed personal values largely mediate interpersonal relationships, policies and procedures mediate interactions with the organization. Outdated policies and procedures, their disregard by members of the community, and lack of implementation and accountability emanating from the higher administration may create the conditions that limit the participation of women in all three dimensions. *Third*, the President and Board of Trustees of UPR are selected by the Governor of Puerto Rico, thus every four years these political changes trickle down to our campus resulting in a significant turnover of chancellors and academic management appointments. *Finally*, Puerto Rico's long-term compound economic (debt crisis), social (population decline and unemployment), and environmental (hurricanes, earthquakes, and COVID-19) crisis have affected UPR, in particular our campus, which is the epicenter of nation-wide demonstrations.

Equity Dimension – Encompasses the opportunities available to women, and fairness principles in the distribution of academic benefits and burdens partially addressed by *Questions 1-4* and *Resources*. Limited recruitment and retention, movement to academic management appointments, and retirement among women may account for the low representation of women in STEM at UPRRP. At the scale of peers, search committees, and personnel committees lack of training on implicit bias and affirmative actions to target women, and ultimately diversifying the pool of applicants are ongoing realities. There is a large variability within and between academic units in terms of gender composition of search committees, wording of job search ads to attract a diverse pool of good candidates, evaluation criteria, and procedures to evaluate candidates and run interviews. Once a candidate has been selected, absence of policies to accommodate dual-career and uncompetitive start-up packages may limit the possibilities for recruiting the best women candidates. Teaching release-time is a critical item in start-up packages and a highly contentious resource in the career of faculty, yet the allocation of teaching release-time varies greatly among units. Upon entrance to the university, UPRRP provides a faculty training and development model [82] yet falls short to address the multiple administrative and academic challenges that new and more experienced faculty in STEM face daily. The assignment of a mentor can be critical in this regard, but this practice and the quality of mentorship can be highly variable among academic units. Efforts to integrate new faculty into existing networks are highly variable too; for the most part these networks are defined by long-standing, men-dominated groups. The challenges for new and existing women faculty extend to mentoring activities in their labs and teaching activities in classroom settings. The reason for this is that students bring with them the same values observed among faculty, that is students place more value on men than women faculty. In addition to the assignment of teaching-release time to conduct research, women may face conflicts with the amount of Service that they may be asked to take outside their 12 FTE's, without compensation, and which are not highly recognized for tenure and promotion.

At the scale of the organization, we have observed a number of positive initiatives reflected in formal structures that have taken several years in the making and that have been *aimed at faculty development but not necessarily at promoting gender equity, diversity and inclusion*. The DAA has consolidated and organized policies, processes, and protocols that mediate faculty-institutional relationships including recruitment and faculty development. In addition, the DAA oversees the implementation of policies but with limited power to hold units accountable. Through the Center for Academic Excellence (Centro de Excelencia Académica - CEA), the DAA offers a training program to new faculty and to faculty in Personnel Committees. A second initiative at DAA has been aimed at *developing evidence-based academic and administrative planning and student learning assessment but not necessarily at promoting the use of data to learn, discover, and promote change.* The DAA's Division of Institutional Research and Assessment (División de Investigación Institucional y Avalúo - DIIA), maintains the Administrative Managerial Support System (Sistema de Apoyo Gerencial Académico y Administrativo – SAGA), and developed an Online Learning Assessment System (OLAS) for graduate students. Major institutional re-arrangements, retirement of personnel, big changes in system-wide databases, and diminished funding not only has affected SAGA but other information systems, including those in Human Resources. We discovered mistakes - big and small - in the dataset that render STEM women invisible, yet we could not get the staff to address these problems.

Economic Dimension – Encompasses the tangible and intangible contributions of STEM women to their discipline and the formal and informal structures that support their productivity partially addressed by *Questions 3-4*, and *Scholarship and Service*. At the individual level, a development plan is not enough for setting-up, maintaining, and developing a research program. This is because the development of a research program involves administrative tasks (purchasing, hiring), recruitment of personnel (students, technicians, and postdocs), learning organization and management skills, building collaborations, identifying sources of funding, and setting standards of excellence as well as achieving life-work balance. Many of our colleagues either during their early years or later on have had to invest considerable amounts of time and energy to establish the foundation from which to launch their careers. The next challenge that they mention is finding colleagues to bounce back ideas, receive constructive feedback for manuscripts and proposals, and learning about new tools and paradigms. The opportunities for this can be limited due to the existence of "clubs", disregard of work conducted by women, and difficulties to communicate across academic units. Finally, the procedures for allocating teaching release-time are highly variable within and between academic units, and it seems that there is limited understanding about the time and effort that is required for the production of knowledge in its various forms (e.g., papers, proposals, patents). This might be particularly important in view of reports that Hispanic names can elicit implicit bias by reviewers.

At the institutional level several policies and procedures can impact women faculty in important ways. The allocation of substitute work or *tareas sustitutas* is a case in point. A new regulation concerning the allocation of substitute time to research (Carta Circular Núm. 8, 2019-2020) establishes a limit of two credits per semester for faculty that do not have externally funded grants. This has the potential to affect women in STEM given that currently they submit fewer proposals and are less successful at obtaining them. Although women have achieved leadership status in our institution, women in STEM with an active research program do not receive robust support to maintain a competitive research agenda and thus may not consider assuming such roles for the duration of their career. The *siloed institutional data culture* hindered the use of data to better characterize problems that women in STEM face in our campus as we have discovered. For example, the analysis of Web of Science data was affected by the lack of a good list of faculty names that could allow us to assign publications to our women faculty. Finally, it is not clear how the institutional funds are allocated to faculty beyond the institutional research grant program known as FIPI. Transparency is key to develop a trustworthy working environment that values merit over special considerations that usually are not evidenced-based.

Workplace Environment Dimension - Encompasses the physical/safety conditions, social interactions/atmosphere, support/recognition, and processes/procedures experimented by women as part of their academic lives partially addressed by *Q4*, *Campus and Environment climate*, and *Pilot studies on Microaggression and Sexual harassment*. Our informal conversations with colleagues do not match any official figure on job harassment or gender discrimination. At the individual level, this may happen because women are unaware that some their experiences result from well characterized behaviors (e. g., implicit bias, sexism, cronyism, mobbing) or because they are ashamed or afraid of sharing their experiences, or because they do not know about existing procedures to denounce their grievances, or because they feel that the institution will not act. At the institutional level, this may happen because the institution does not provide clear and easy access to resources that are critical to build awareness, document, and mitigate behaviors that affect the workplace environment. Also, at the institutional level the CBA job satisfaction

report, suggests that UPRRP's "*hierarchical organization structure*" prevents collaborative decision-making; in turn, such structures limit inclusion and transparency at all levels. This structure has solidified with each year of budgetary cuts as the institution seeks to maximize economic efficiencies with disregard to the wellbeing of their members. Finally, and not the least, UPRRP does not provide visibility, recognition, or celebrate the accomplishments of all this faculty in a consistent manner.

6 A multi-dimensional and multi-scale strategy for the sustainable participation of academic women in STEM at UPRRP

Overview - Using a Theory of Change approach [15, 33, 34] we linked problems with drivers, and ultimately designed a strategy aimed at transforming and promoting the advancement of women in STEM at UPRRP. Combining Sustainability Principles and Hierarchy Theory into a single framework (Figure 5a) allowed us to recognize the multiple dimensions, and scales of interaction that determine the participation of academic women in STEM. Including the concept of Gendered Academic Citizenship allowed us to establish relationships between sustainability and citizenship, and ultimately design a strategy for sustainable systemic change (Figure 5b). Specifically, we propose to combine and run in tandem top-down and bottom-up approaches that complement each other. The first, will enable campus-wide recognition and accountability for women in STEM by conducting awareness and educational campaigns that leverage tools (e.g., apps, websites, social media) and place them in the hands of as many stakeholders as possible to turn them into activists for gender equity. The second, will promote policies to enhance a sense of membership and belonging for women in STEM. This requires working with organizational structures (DAA, OPA, DSMR, Deanship of Graduate Studies and Research, Colleges and Schools, and graduate student organizations) to design and promote new policies aimed at gender equity, diversity, and inclusion (DEI). The combination of both approaches is expected to induce changes that are likely to survive the political and economic vagaries that affect our institution every four years, therefore contributing to sustainable change. UPRRP is poised to recruit new faculty over the next 2 years at a time of a compound crisis. By acting *now* the institution can take advantage of the small windows of opportunity to elicit systemic change [83].

Key Elements of the Approach - Two *cross-cutting themes*, namely Open Data Science and Gendered Academic Citizenship have been identified, that aim at promoting cross-scale interactions between faculty and the Administration, and interactions among diverse STEM faculty that transcend functional and disciplinary barriers (Figure 6). A first cross-cutting theme aims at changing the "*siloed institutional data culture*" to empower stakeholders with tools, techniques, infrastructure, and mindsets that can harness the *Big Data* revolution, in particular open data science which calls for inclusion, openness, transparency, and reproducibility while protecting sensitive information [67,84,85]. A proposal to partner with the DIIA and UPR's Central Administration new project that uses the business analytic service of Microsoft Power BI for data-discovery is suggested. The second cross-cutting theme is drawn from Gendered Academic Citizenship [12] and the impact of membership, recognition, and belonging on women's academic citizenship and full participation in STEM. Partnering with DAA, OPA, and Human Resources to implement strategies that provide equity in the workplace, and hold

academic units and the institution accountable for fair and inclusive practices is recommended.

In addition to the cross-cutting themes, it is recommended that the institution focus on three focal dimensions aimed at developing multi-scale initiatives and removing barriers that limit the full participation of women in STEM. A list of activities that do not duplicate previous ADVANCE efforts are suggested.

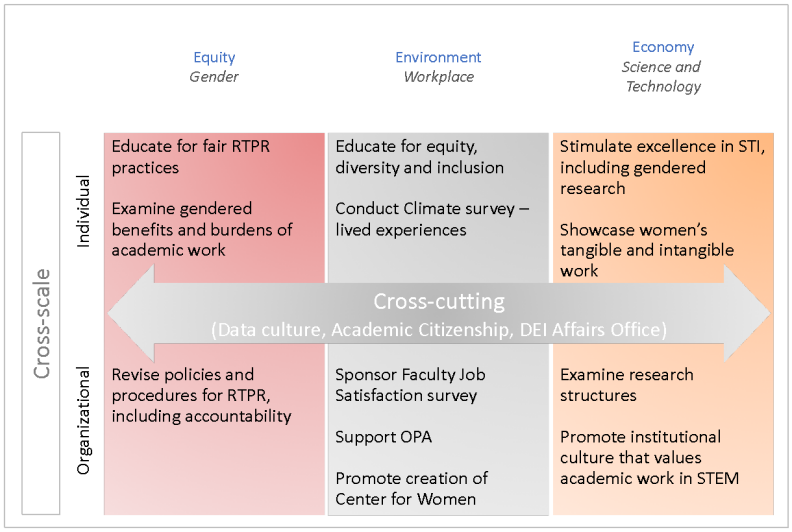

Figure 6. Overall strategy highlighting approaches (small- and large-scale) and broad aims for both the cross-cutting themes (Open data culture and, Gendered Academic Citizenship) and dimensions (Equity, Environment, and Economy). Each broad aim has targets and indicators that could help assess measurable outcomes of activities, interventions, and research towards women's access to full academic citizenship. Abbreviations: RTPR, recruitment, tenure, promotion, and retention; OPA, Office of Compliance and Audit. DEI, Diversity, Equity, and Inclusion.

Equity – (1) Apps and web pages to document, monitor, and evaluate recruitment, tenure, promotion, and retention (RTPR) – from job advertisements and pool of applicants and start-up packages, to distribution of resources, including teaching-release time, (2) Equity advisers to educate and monitor RTPR, (3) Semi-annual focus groups to process and explore the experiences and perceptions of stakeholders as a result of the community-informed educational interventions, (4) Big Data and textual analysis to study RTPR policies, procedures, and accountability mechanisms

Workplace Environment - (1) Awareness and educational "market" campaign that leverage tools (e.g., apps, websites, social media) and Big Data to create a campus-wide equitable and safe environment in which our community can thrive, (2) Support campus-wide women organizations, (3) Assist OPA in the creation of an environment (apps, websites, procedures) that invites women and other members of the community to share their experiences and find justice, (4) Undertake campus-wide Faculty Job Satisfaction and Perception of the Workplace surveys and compare with previous ones to understand the effects of the compound crisis.

Economy - (1) Training in critical professional skills (mentorship, grant/creative writing, open/big data, networking, entrepreneurship/IP/copyrights, use of social media platforms, service), (2) Promote changes in organizational culture to facilitate pre- and post-award grant management, (3) Increase visibility of women in STEM through the development of partnerships within and outside, and the redesign of personal/departmental/institutional websites, and (4) Promote open practices in committees that manage resources critical to the advancement of STEM.

7 Recommendations

Based on the data presented, it is imperative to develop a series of institutional interventions that will improve faculty development and retention with a special focus on achieving equity and inclusive excellence for women faculty in STEM fields. Furthermore, the need for a diverse faculty has become even more pronounced in the face of challenges presented by an increasingly multicultural student body pursuing opportunities in a knowledge-based global economy. In addition, recommendations to extend opportunities for the women faculty to attain equity in access to exclusive opportunities and effective professional developmental programs is crucial in the future development of our institution in the 21st century. Equity, a commitment to intersectionality and inclusive excellence for the women faculty are important measurable outcomes in the present report.

However, despite an expressed desire to diversify their faculty, the UPR has struggled to make significant progress. To address this challenge, it is important to employ best practices to hire, promote, and retain the diverse faculty talent that does exist. Academic institutions that are serious in their desire to enhance their faculty diversity can do so, but they must be aggressive, intentional, creative, and focused on creating change over time. Thus, the present report aims at addressing and tackling the barriers to increasing diversity in academic structures and empowering its women STEM faculty with the professional and scientific competencies to continue a successful career path in the STEM related biomedical research.

Preliminary results point out the urgency to consider microaggressions as a systemic problem on campus. To do so, a more comprehensive and representative sample of this preliminary study is needed. Further analysis should include a model that allows us to evaluate the moderating or mediating effect of intersectional variables such as age, gender identity and racial identity on the perception of microaggressions. The preliminary results synthesized for this report lead to reflecting towards how our institution confronts actual discursive contexts and delivers specific actions to address an academic climate in which not only women perceive themselves as valued and validated, but also in that direction, their research and other academic contributions are strengthened and enhanced. As one of the most prominent Hispanic Serving Institutions in the region, we have an incredibly unique opportunity to amplify our efforts to critically analyze the present situations that our female professors and graduate students are currently experiencing and how the institution can transform itself in coherence with the mission of the University of Puerto Rico.

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Appendices

Appendix 1 – Group and individual meetings that we held with different stakeholders during September 2020 – January 2021.

Year	Meeting Date	Purpose	Attendees
2020	09/25/20	First meeting to organize NSF-Advance proposal submission	Carmen Madonado, Vilmali Lopez, Carla Restrepo
2020	10/02/20		Carmen Madonado, Vilmali Lopez, Carla Restrepo
2020	10/09/20	Meeting w/ Leadership of the Deanship of Academic Affairs	Ilenia Ortega, Leticia Ferandez, Clarisa Cruz, Isabel Montanez, Carmen Madonado, Vilmali Lopez, Carla Restrepo
2020	10/16/20	Meeting w/ Idalia Ramon former NSF-Advance grantee	Idalia Ramon, Carmen Madonado, Vilmali Lopez, Carla Restrepo
2020	10/16/20	Meeting w/ Elithet Silva	Carla Restrepo, Elithet Silva
2020	10/23/20		Carmen Madonado, Vilmali Lopez, Carla Restrepo
2020	10/23/20	Meeting w/ Aurora Sotogras Dean of Administration	Carla Restrepo, Autora Sotogras
2020	10/28/20	Meeting w/ Title IX Officers at UPR	Sonia Ortiz, Edith Gonzalez, Gabriela Medina, Carmen Madonado, Vilmali Lopez, Carla Restrepo
2020	11/03/20	Meeting w/ Elithet Silva	Carla Restrepo, Vilmali Lopez, Elithet Silva
2020	11/06/20	Meeting w/ Leadership of the DEGI	Carlos Gonzalez, Lorna Jaramillo, Ana Feliciano, Nivia Fernandez, Carmen Madonado, Vilmali Lopez, Carla Restrepo
2020	11/12/20	Meeting w/ Title IX Office	Carla restrepo an Sonia Ortiz
2020	11/13/20		Carmen Madonado, Vilmali Lopez, Carla Restrepo
2020	11/13/20	Meeting w/ Yarimar Rosa	Carla restrepo, Yarimar Rosa
2020	11/20/20	Meeting w/ potential social scentists collaborators	Elithet Silva, Yarimar Rosa, Carmen Madonado, Vilmali Lopez, Carla Restrepo
2020	11/20/20	Meering w/ Nivia Fernandez of DEGI	Carla Restrepo, Nivia Fernandez
2020	12/11/20		Elithet Silva, Carmen Madonado, Vilmali Lopez, Carla Restrepo
2020	12/18/20	Meeting w/ potential computer/information scentists collaborators	Carlos Corrada, Patricia Ordonez, Humberto Ortiz, Elithet Silva, Carmen Madonado, Vilmali Lopez, Carla Restrepo
2021	01/12/21	Meeting w/ Jose Ubaldi	Carla Restrepo, Jose Ortiz Ubarri
2021	01/20/21	Meeting w/ Rebeca Guadalupe of Deanship of Administration	Carla Restrepo, Rebeca Guadalupe
2021	01/22/21	First Coordination Meeting of the Semester	Yarimar Rosa, Carmen Madonado, Carla Restrepo
2021	01/22/21	Set up calendar to submit pre-proposal/CIPSHI	Elithet Silva, Yarimar Rosa, Carmen Madonado, Vilmali Lopez, Carla Restrepo
2021	01/25/21	Meeting w/ Rebeca Guadalupe of Deanship of Administration	Carla Restrepo, Rebeca Guadalupe
2021	01/26/21	Meeting w/ Leticia Fernandez e Isabel Montañez of DAA	Carla Restrepo, Leticia Fernandez, Isabel Montañez
2021	01/28/21	Meeting w/ Isabel Montañez y Sandra Florez of DAA	Carla Restrepo, Sandra Florez, Isabel Montañez
2021	01/28/21	Meeting w/ Denise Lopez y Maria Castro of DEGI	Carla Restrepo, Denise Lopez, Maria Castro
2021	01/29/21		Elithet Silva, Yarimar Rosa, Carmen Madonado, Vilmali Lopez, Carla Restrepo
2021	02/01/21	Meeting w/ Zulyn Rodriguez DTAA	Carla Restrepo, Zulyn Rodriguez
2021	02/02/21	Meeting w/ Jose Corrales Junta Administrativa	Carla Restrepo, Jose Corrales
2021	02/02/21	Meeting w/ Jamiesselle Maldonado of Recursos Humanos	Carla Restrepo, Jamiesselle Maldonado
2021	02/02/21	Meeting w/ Mayra Roman Academic Assistant Biology	Carla Restrepo, Mayra Roman
2021	02/02/21	Meeting w/ Basilio Rivera of Presupuesto	Carla Restrepo, Basilio Rivera
2021	02/03/21	Meeting w/ Angela Pelet Administrator Biology	Carla Restrepo, Angela Pelet
2021	02/05/21		Elithet Silva, Yarimar Rosa, Carmen Madonado, Vilmali Lopez, Carla Restrepo

Year	Meeting Date	Purpose	Attendees
2021	02/08/21	Meeting w/ pre-award office staff	Yarimar Rosa, Carmen Madonado, Vilmali Lopez,
2021	02/08/21	Meeting w/ Jose Luis Ayala Vice-presidencia Investigacion UPR Central Administration	Carla Restrepo, Jose Luis Ayala
2021	02/12/21		Elithet Silva, Yarimar Rosa, Carmen Madonado, Vilmali Lopez, Carla Restrepo
2021	02/17/21	Meeting w/ Basilio Rivera of Presupuesto	Carla Restrepo, Basilio Rivera
2021	02/19/21	Division of work for preproposal	Elithet Silva, Yarimar Rosa, Carmen Madonado, Vilmali Lopez, Carla Restrepo
2021	02/26/21		Elithet Silva, Yarimar Rosa, Carmen Madonado, Vilmali Lopez, Carla Restrepo
2021	03/03/21	Meeting w/ Arleen Hernandez College of Business Administration	Carla Restrepo, Arleen Hernandez
2021	03/04/21	Meeting w/ Jose Pabon y Heriberto Luna of OSI UPR Central Administration	Carla Restrepo, Jose Pagon, Heriberto Luna
2021	03/05/21		Elithet Silva, Yarimar Rosa, Carmen Madonado, Vilmali Lopez, Carla Restrepo
2021	03/05/21	Meeting w/Griselle Melendez College of Business Administration	Carla Restrepo, Griselle Melendez
2021	03/12/21		Elithet Silva, Yarimar Rosa, Carmen Madonado, Vilmali Lopez, Carla Restrepo
2021	03/17/21	Meeting w/ Yarimar Rosa	Carla Restrepo Yarimar Rosa
2021	03/19/21		Elithet Silva, Yarimar Rosa, Carmen Madonado, Vilmali Lopez, Carla Restrepo
2021	04/02/21		Elithet Silva, Yarimar Rosa, Carmen Madonado, Vilmali Lopez, Carla Restrepo
2021	04/04/21	Meeting w/ Isabel Montañez of DAA	Carla Restrepo, Isabel Montañez
2021	04/16/21		Elithet Silva, Yarimar Rosa, Carmen Madonado, Vilmali Lopez, Carla Restrepo
2021	08/27/21		Elithet Silva, Yarimar Rosa, Carmen Madonado, Vilmali Lopez, Carla Restrepo
2021	08/31/21		Elithet Silva, Yarimar Rosa, Carmen Madonado, Vilmali Lopez, Carla Restrepo
2021	09/03/21		Elithet Silva, Yarimar Rosa, Carmen Madonado, Vilmali Lopez, Carla Restrepo

Appendix 2 - Request of institutional information

Appendix 3 – CIPSHI

Appendix 4 - *Integrating a critical analysis towards transformations on equity and – A pilot study on gender microaggressions and sexual harassment (Yarimar Rosa-Rodriguez, Elithet Silva Martínez and Valerie Ascencio Torres*

Introduction

The term microaggressions comprise a wide range of actions take upon a person or a group of people particularly vulnerable or underrepresented. They tend to be subtle alas its name implies the microlevel of action. Nevertheless, the subtleness of those actions has psychological effects on targeted people not only at work but in everyday life.

The invalidation of sexism as a present reality is one of the major obstacles to address inequity in any context, especially in academia. Although explicit behaviors such as the use of sexist language may not be as present as implicit manifestations of sexism, it is important to pay attention to how subtle (but still violent) exchange within the academic environment and how it interacts with general norms of political correctness. When analyzing the microaggressions using Liker-scale instruments, we found that high and positive correlations for the sexist language factor can be explained due to the current self-awareness on the use of words, phrases or terms widely discussed as violent in an explicit way. For this reason, it is important to highlight that while sexist language presents a low average for women professors, when observing the correlations between the subscales, it presents a strong relationship with explicit threatened physical safety. Therefore, although the use of sexist language is not experienced as much as other instances of microaggressions, when this language occurs, it can be perceived as an explicit threat to the safety of professors. On the one hand, it is important to honor the efforts to attend to explicit manifestations of sexism as it relates to equity. However, the fact that factors related to invalidation, dismissal, and other implicit manifestations represent symbolic violence makes it harder to act on. The challenge lies in that perceptions of invalidation, and other types of implicit oppression against women makes it harder to recognize and address sexist and hostile environments for women to advance on their careers as well as to feel they pertain to academia.

One of the most common forms of violence against women is gaslighting. Although mostly used to explain violence at the interpersonal levels, Sweet [86] explains that there is the urgent need to look at gaslighting not only from a psychological perspective, but also from a sociological lens and its relationship to the perpetuation of violence at the institutional levels. When female academics can certainly identify a low presence of overt forms of sexism, such as sexist language, but simultaneously face invalidation of oppressions related to gender, then systemic representations of inequity occur. Thus, there is an absolute need to not only recognize, but to combat those concealed, but pervasive, forms of symbolic violence and power imbalances at the structural and systemic levels.

Another important element to consider is the moderate and positive correlation between Invalidation of the Reality of Sexism and Assumptions of second-class citizen among female professors. There is extensive evidence in scientific literature that links invalidation with gaslighting. The fact that women feel that the forms of oppression that they have been subjected to, such as sexism, is minimized, a greater sense of exclusion may take place. There is a definite need for an in-depth examination of how power imbalances in academic institutions are

contextualized into a patriarchal society in which gender violence and inequity permeates at various levels of societal life.

An essential piece of this preliminary study included obtaining primary data from female faculty and graduate students to explore microaggressions and sexual harassment on campus. This study takes into consideration the Gender Microaggressions Theory [43], which define microaggressions as "brief and commonplace daily verbal, behavioral and environmental indignities that communicate hostile, derogatory or negative sexist slights and insults toward women (p. 197). Gender microaggressions \ have a devaluating effect on women's contributions [87], on workplace like universities. The general objective of this study phase was to explore the mediating effect of bullying, harassment, microaggressions and gender bias in the exercise of academic citizenship of female teachers and students. To do this, we proposed a mixed sequential design that allows the collection of quantitative data in one time and qualitative in a second time. This report includes preliminary descriptive data and correlational analysis from the quantitative data we collected through an online questionnaire.

Methods

IRB- Ethics- We presented the research protocol to the Comité para la Protección de Seres Humanos en la Investigación (CIPSHI), as the Institutional Review Board (IRB) for review and authorization of this project. We attended to observations and recommendations of the committee before implementing the research protocol and we have responsibly notified all the changes or modifications that have taken place for its continuity.

Recruitment - For this phase of the study, we began recruiting participants through institutional mailing lists. We asked the campus Communications Office to send the respective announcements to the list of graduate students as well as to faculty. We also communicated directly with the Students Assistant Deans of each college so that they could send the announcement to their mailing lists. In addition to this, we asked directors of academic departments to send communication to the faculty. The potential participants received a brief description of the project accompanied by the link to access the electronic questionnaire. We programmed a questionnaire for students and another for professors using Google Forms. Each participant had the opportunity to review the Informative Form. Those willing to participate had to press the accept button to access the survey questions.

Instruments - The following instruments were used: 1) Sociodemographic survey; 2) Female Microaggressions Scale; 3) Scale of sexual harassment and social interaction of sexual content at the university level.

Sociodemographic survey - The first section of the online survey is composed of 13 sociodemographic questions that allow describing the sample. The questions include the following: age, gender identity, sexual orientation, country of origin, number of years living in Puerto Rico, years in the teaching position (for the faculty), faculty, department, or academic unit,

Female Microaggressions Scale (FeMS) [69] To evaluate the levels of microaggressions perceived by the population of graduate students and female professors, it was necessary to use a scale that was originally written in English. For the translation, a fellow professor did an initial translation. Subsequently, a graduate student who speaks English as a native proceeded to do the reverse translation from Spanish to English. As a third step, the main researcher of this phase made the concordance analysis of the scales that yielded 95%. The research team discussed the terms used in the Spanish version to establish linguistic correspondence in relation to the context of Puerto Rico. A final version was established. This scale has a bi-factorial model with eight dimensions and a general FeMS. The general factor offers a total score of the occurrence of instances of microaggressions experienced by the sample. Each item is answered with a 4-point Likert scale ranging from never (1 point), a little/ rarely (2 points), sometimes / moderate amount (3 points), to often/ frequently (4 points). The eight subscales area as follow: 1) assumptions of traditional gender roles, 2) sexist language, 3) implicit threatened physical safety, 4) explicit threatened physical safety, 5) invalidation of the reality of sexism, 6) assumptions of inferiority/ second-class citizen, 7) environmental, 8) sexual objectification. For the present study Cronbach's Alpha was 0.962 for the professor sample using a 34-item version and 0.943 for students.

Scale of sexual harassment and social interaction of sexual content at the university level (EASIS-U)[7] [70]- Participants were asked about a series of behaviors related to sexual harassment and social interaction of sexual content in academia using the Scale of sexual harassment and social interaction of sexual content at the university level developed in Spain [70]. The original scale, which comprises four subscales, contained 38 items that describe different behaviors of social interaction with sexual content and sexual harassment. Nineteen items assess behaviors of sexual blackmail, that is, the existence of a strong coercion to achieve sexual intercourse not consented; six items evaluate sexual harassment with a verbal component (looks, insinuating comments, obscene jokes, etc.); seven items assess the physical component sexual harassment (touching, of diverse scope) and, finally, six items evaluate behaviors of social interaction of sexual content that they have place in the university setting (starting a relationship volunteer for both parties, coincide in a party or meeting, etc.). Response options ranged using a four-point scale: 1 (Never happened at the university level); 2 (Sometimes it has happened in the university environment); 3 (Often it has happened at the university level; 4. (Many times it has happened in the university setting). The overall scale for our sample had a Cronbach's alpha of .959.

Participants - We performed descriptive statistical analysis for all sociodemographic data. Table A1 presents the frequencies and percentages for the demographic variables using the female sample (n= 47) comprised of women faculty and graduate students as well as responses related to how they saw their areas of research/study to STEM. It is important to provide specific data of both groups to account for differences in demographics that might impact on the research outcomes. Participants from the faculty sample (n = 18) ranged in age from 21 to 70 years of age. However, 72.1% of the subsample ranged between 41 and 60 years of age. In terms of gender, the totality of this sample reported a feminine gender identity while regarding sexual orientation, 88.9% self-reported as heterosexual, 5.6% as bisexual and 5.6% preferred not to reveal their sexual orientation. On country of origin, almost 84% of this sub-sample reported Puerto Rico as

[7] Acronyms in Spanish

their country of origin, while 16.7% reported Colombia and Cuba as their country of origin. Of those whose country of origin is not Puerto Rico, 5.6% has lived in the island between 11-20 years, 5.6% between 31-40 and more 5.6% more than 51 years. When it comes to the faculties represented in this subsample, 55.6% belong to Natural Sciences, while almost 45% belong to Business Administration, Social Sciences, Law School, Architecture, General Studies and Planning. When asked about research associated with STEM disciplines, 83.3% of the female professors responded affirmatively, while 16.7% did not associate their research with STEM.

Table A1. Sociodemographic Characteristics of Women Participants

Variables	Female professors		Female Graduate students		All	
	n	%	*n*	%	*n*	%
Age						
21 – 30	1	5.6	18	61.2	19	40.4
31 – 40	2	11.1	7	23.8	9	19.1
41 – 50	6	33.1	4	13.6	10	21.2
51 – 60	7	39.2	0	0	7	14.8
61 – 70	2	11.1	0	0	2	2.3
Gender Identity						
Female	18	100	29	100	47	100
Sexual Orientation						
Heterosexual	16	88.9	25	86.2	41	87.2
Lesbian	0	0	1	3.4	1	2.1
Bisexual	1	5.6	1	3.4	2	4.2
Asexual	0	0	1	3.4	1	2.1
Bisexual with preference in men	0	0	1	3.4	1	2.1
I prefer not to answer	1	5.6	0	0	1	2.1
Country of origin						
Colombia	2	11.1	1	3.4	3	6.3
Dominican Republic	0	0	1	3.4	1	2.1
Cuba	1	5.6	0	0	1	2.1
Puerto Rico	15	83.3	27	93.1	42	89.3
Years living in Puerto Rico						
Born and raised in Puerto Rico	15	83.3	25	86.2	40	85.1
1-10	0	0	2	6.9	2	4.2
11-20	1	5.6	0	0	1	2.1
21-30	0	0	0	0	0	0
31-40	1	5.6	1	3.4	2	4.2
41-50	0	0	0	0	0	0
51 or more	1	5.6	0	0	1	2.1
Affiliated College						
Business Administration	1	5.6	2	6.9	3	6.3
Natural Sciences	10	55.6	2	6.9	3	6.3
Social Sciences	1	5.6	15	51.7	16	34
Law School	1	5.6	2	6.9	3	6.3
Education	0	0	6	20.7	6	12.7
Humanities	0	0	2	6.9	2	4
Architecture	2	11.1	0	0	2	4.2
General Studies	2	11.1	0	0	2	4.2
Graduate School of Planning	1	5.6	0	0	1	2.1
Consider that your study / research is related to STEMS disciplines						
Yes	15	83.3	6	20.7	21	12.7
No	3	16.7	14	48.3	17	36.1
I don't know	0	0	9	31	9	19.1

Participants from graduate student subsample (n=29) ranged in age from 21 to 50 years of age. Almost 62% of the subsample ranged between 21 and 30 years of age, while 23.8% ranged between 31 and 40 years of age and 13.6% ranged between 41 and 50 years of age. When it comes to gender identity, the totality of this sample reported a feminine gender identity. Regarding sexual orientation, 86.2% self-reported as heterosexual, and 13.6% of the respondents identified as lesbian, bisexual, asexual, and bisexual with preference in men. Related to country of origin, 93.1% of the female graduate students reported Puerto Rico as their country of origin, while 6.8% reported Colombia and the Dominican Republic as their country of origin. Of those graduate students whose country of origin is not Puerto Rico, 6.9% has lived in the island between 1-10 years and 3.4% between 31-40 years. Participants reported their affiliated college as follows: 51.7% affiliated themselves to Social Sciences, 20.7% to Education, and 27.6% were equally represented form Natural Sciences, Business Administration, Law School and Humanities. When asked about research associated with STEM disciplines, 48.3% of this subsample did not

associate themselves with STEM, 31% responded not being sure, while 20.7% did associate their research/study area with STEM.

Results

Table A2. shows the means and standard deviations for the total FeMS scale as well as the subscales for women faculty. The total average of the scores (M =83.56; SD = 20.52) presents a moderate to high occurrence of instances of microaggressions among professors. On the other hand, Table 4 presents a high occurrence (M = 94.27; SD = 21.39) of these situations for female students. Both samples present moderate to high averages for the following subscales: invalidation of the reality of sexism, environmental, and implicit threatened physical safety; and a low mean for sexist language.

Table A2. FeMS Means and Standard Deviations for faculty (n = 18) and student (n =

	Faculty		Students	
	Mean	SD	Mean	SD
Traditional Gender Roles	10.28	3.61	11.97	3.34
Sexist Language	5.50	1.76	8.00	3.48
Invalidation of the Reality of Sexism	**13.78**	4.02	**14.79**	3.86
Environmental	**12.44**	2.81	**13.21**	2.62
Implicit Threatened Physical Safety	**11.44**	3.55	**13.21**	3.34
Explicit Threatened Physical Safety	9.11	2.76	10.10	3.15
Assumptions of Inferiority / Second Class	10.28	3.82	11.17	4.16
Sexual Objectification	10.72	2.70	11.83	3.19
Total	**83.56**	**20.53**	**94.28**	**21.39**

Since the FeMS scale has an eight-dimensional factorial structure with a first-order factor for the microaggression construct in general, we proceeded to evaluate the correlations between the subscales for both samples using Spearman's rho coefficient. Table A2. shows the correlations

Table A3. Score Spearmen correlations among the eight FeMS dimensions. **correlations significant at the 0.01 level (2-tailed); *correlations significant at the 0.05 level (2-tailed). In grey xxxxxx

		FeMS dimensions													
		Faculty (n = 18)							Graduate students (n =)						
FeMS dimensions		1	2	3	4	5	6	7	1	2	3	4	5	6	7
Traditional Gender Roles	1														
Sexist Language	2	.644**							.475**						
Invalidation of the Reality of Sexism	3	.731**	.676**						.497**	.571**					
Environmental	4	.745**	0.345	0.417					.661**	.748**	.738**				
Implicit Threatened Physical Safety	5	.738**	.482*	0.423	.570*				.371*	0.233	.454*	.393*			
Explicit Threatened Physical Safety	6	.758**	.745**	.773**	.507*	.621**			.677**	.573**	.734**	.775**	0.297		
Assumptions of Inferiority / Second Class Citizen	7	.737**	.529*	.546*	.549*	.507*	.598**		.637**	.657**	.571**	.745**	0.33	.647**	
Sexual Objectification	8	.470*	.631**	0.317	0.37	.476*	.628**	.734**	.568**	.379*	.545**	.550**	.456*	.671**	.406*

for the FeMS answered by professors, while Table A3. shows for students. High and positive correlations are found for professors on the subscale of traditional gender roles with invalidation of reality of sexism (r_s = .731; p < .01), environmental (r_s = .745; p < .01), implicit threatened physical safety (r_s = .738; p < .01), and explicit threatened physical safety (r_s = .758; p < .01), and assumptions of inferiority / second class citizen (r_s = .737; p < .01). Furthermore, the explicit threatened physical safety factor obtained high and positive correlations with sexist language (r_s = .745; p < .01) and invalidation of the reality of sexism (r_s = .773; p < .01).