How to improve the research cultural environment

previous

Chapter V: Gender in Research and Education as a lens into gender-inclusive organizational cultures

In this section, another branch of literature concerned with how women in physics, and female scientists in general, are portrayed within the organizational culture, as well as how various dimensions of scientific research impede or strengthen women's chances of success in STEM. Again referring to the GENERA's Field of Action, the literature examined here deals with "Gender-inclusive/Gender-sensitive Organizational Culture and Gender Dimension in Research and Education". The reason behind this approach is that subfields in these two themes are oftentimes linked in subject literature. In other words, studies on stereotyping, awareness and bias, excellence and non-discrimination, are framed through the observations, and actions to alter the climate of general knowledge production, research environment and funding schemes updated.

The persistent underrepresentation of women vis-à-vis overrepresentation of men in Science, Technology, Engineering, and Mathematics (STEM) elicited a debate of not only the causes but also the potential mechanisms able to counter this imbalance and gender inequality (e.g. Blomkvist et al. 2010; Hasse, Trentmoller 2008; Ceci, Williams 2011; Chesler et al. 2010; Cunningham 2013; Dever, Morrison 2009; Hill, Corbett, Rose 2010; Kelly 2016). Most commonly, the possible factors contributing to the discrepancy of women and men in STEM jobs, include a lack of female role models, gender stereotyping, and the already covered less family-friendly flexibility in the STEM fields (Beede et al. 2011: 5). According to Williams et al. (2014) the numbers of women missing from STEM, given the current rates of training in science, technology, math, and engineering persist, will mean a one million deficit of engineers and scientists in the US (see also Etzkowitz et al., 2000).

In recent UPGEM study, Hasse and Trentmoller (2008) demonstrated that masculinist organizational culture is not monolithic, but rather operates differently across various states. In physics, "the directive force of the organization of cultural knowledge about how best to act in everyday life as a physicist" formulated three different leading ideal types as cultures. These scientific cultures were typified as Hercules, the Caretakers and the Worker Bees. The summary of the differences between the driving forces in these three internationally divergent instances of cultural enactments can be seen in the table below (Hasse, Trentmoller, 2008:97; see also Godfroy, Genin 2009).

Cultural models	**HERCULES**	**CARETAKERS**	**WORKER BEES**
Work relation	Physics is the only thing	Physics is everything but must be socially acceptable	Physics is not everything in their life
Workplace Identity	Focus is on ego	Focus is on the group	Focus is on the task and family and friends
Competition	1-on-1 fights using all means available	Group versus group	Uninterested in competition
Power relations	Anti-authoritarian with hidden power games	The group requires young members work their way up	Formal hierarchy

Gender in the cultural models	**HERCULES**	**CARETAKERS**	**WORKER BEES**
Gender	Used as a negative element e.g. in competition	Acceptance of gender roles in relation to groups and not used negatively e.g. in competition	Not used negatively in e.g. competition

In their recent review, Savonnick and Davidson noted that “culture and representations play an important role in perpetuating gender bias within and beyond academe” (2016: str?). Cultures - on the level of workplace, organizations in a nation-wide context, as well as pan-nationally, they constitute conditions to which everyone must adhere to, scientists notwithstanding. Male culture was foregrounded by early-career physicists interviewed by Whitelegg et al. (2002) interviewees there mentioned the 'lads' culture of 'going down the pub' after work to discuss work/research. This type of “boys club” were alluded to be needed for success, forced women to partake in them to prove they are part of the team, even though conversations verged towards “sports and girls” on-site. Moreover, “the women reported that their male colleagues felt that it was OK to ask a woman out to the pub or for a meal to discuss work, but the women felt unable to do the same because ”*it wouldn't look professional*“ (Whitelegg et al. 2002). The female physicists perceived their departmental culture as confrontational, self-confident, self-assuring, and reliant on men sharing of new ideas and contacts amongst themselves. Women fall victim to the dominant “way of doing things”, with one scientist saying ”*I think women in a scientific environment really do have to … be more male in a way. They do have to try not to change the system too much, but try to adapt to the system*“.

Physics research communities exhibiting masculinized notions of physics was further studied in recent project entitled “genderDynamics. Disciplinary Cultures and Research Organizations in Physics”. It was conducted in German universities, non-university research institutions and excellence clusters, and examined the entanglements and disentanglements of gender cultures and disciplinary cultures for the case of different physical sciences (Erlemann 2014; Lucht 2016).

These and other studies demonstrate that “the discipline of physics is not only dominated by men, but also is laden with masculine connotations on a symbolical level, and that this limited and limiting construction of physics has made it difficult for many women to find a place in the discipline” (Gonsalves, Danielsson, Pettersson 2016: 1). Physics laboratories are especially seen to be the arenas for masculine performances, comprising of “physical skill, the ability to use machines, and (…) creativity or tinkering in relation to the use of machines” (Gonsalves, Danielsson, Pettersson 2016: 13; see also Traweek 1992; Pettersson 2011; Dasgupta 2016). Similarly the masculine norms of long working hours and international mobility contribute to the construction of the ideal worker, who is productive, as well as committed and dedicated to science. Apart from the dimension of symbols and images, the norm of masculinity is also manifested in interactions, and mental constructs. In the interactional dimesion, there exist “discrimination, sexual harassment, and the social expectation that a female physicist should act as if she were one of the boys” (Rolin, Vainio 2011: 40). In the mental dimension, some female physicists adopt “the strategy of behaving as one of the boys in order to cope with a male-dominated working environment”. (Rolin, Vainio 2011: 40-41).

Leading the proceedings of the NAS events and agenda, Moss-Racusin et al. (2012: 16474) acknowledged that gender biases stem “from repeated exposure to pervasive cultural stereotypes that portray women as less competent but simultaneously emphasize their warmth and likeability compared with men”. Gender bias is salient and pervasive on the general level, but particularly necessitates attention that is discipline-specific. This is because various fields reproduce the patterns of uniqueness in regard to protocols of hiring, promotion, tenure, assessment, and similar aspects. Though methods, forms and metrics may vary by branch or field, they are atypically gender-blind and commonly mirror gender bias present in a given setting (Savonnick, Davidson, 2016). Williams et al.

(2014) see at least two reasons behind the STEM fields being fertile grounds for bias. Firstly, tokenism studies elaborate on the high probability of bias when women make up less than 15% - 20% of a given field, which is common in many fields of science, including physics. Secondly, Moss-Racusin et al. (2012) and Castilla and Benard (2010) tackle the philosophy of science and find that sciences that perceive themselves as objective, numbers-based and meritocratic, tend to exhibit much more actual proneness to bias.

While being concerned with the negative outcomes of organizations non-inclusive towards women in academia is not new (e.g. Rossi 1965, De Peslouan, 1974) and has grown considerably, less consensus can be observed in regard to what the root causes behind the women-excluding organizational cultures (Smeding 2012). Halpern et al. reviewed considerable number of literature and, although they supply a number of biology-driven and evolutionary concerns, they also point out that “a wide range of sociocultural forces contribute to sex differences in mathematics and science achievement and ability—including the effects of family, neighbourhood, peer, and school influences; training and experience; and cultural practices” (2007: 2). In the realms of early experience, biological factors, educational policy, and cultural contexts affecting women and men who pursue advanced study in science and math, gender stereotyping is one of the key patterns.

Although some of them have boasted more explanatory power than others, the following are the culture-related perceived causes of women's absence in research organizations in STEM:

- biological differences between men and women
- girls' lack of academic preparation for a science major/career
- girls' poor attitude toward science and lack of positive experiences with science in childhood
- the absence of female scientists/engineers as role models
- science curricula are irrelevant to many girls
- the pedagogy of science classes favors male students
- a 'chilly climate' exists for girls/women in science classes
- cultural pressure on girls/women to conform to traditional gender roles
- an inherent masculine worldview in scientific epistemology (see Blickenstaff, 2005).

The negative effect is quite straightforward as women are perceived as having lower capacity of dealing with numbers (Cejka, Eagly 1999) and prevalence to handle words rather than things (Lippa 1998). This in turn translates to girls and women loosing self-confidence, lacking in performance, and ultimately losing interest in pursuing a career in the disciplines that are counter-stereotypical, especially STEM field as the pinnacle of masculine areas in research (Eccles et al. 1990, Jakobs 1991). The stereotype is threatening in way that negative views may be exposed to a group's unjust confirmation and, effectively, hinder and underline girls' achievements in mathematics and adjacent subjects[1)]).

Across studies, wider societal perceptions usually associate SET/STEM occupations with men (Glover 2002, Ivie et al. 2003, Lewis, Humbert 2010). The male-dominated workforces, by design, tend to be operating with a masculine culture (Lewis, Humbert 2010). That is, they promote and value individualistic rather than collaborative behaviours, with commitment defined in terms of masculine norms of long working hours and total availability (Glover, 2002). Some evidence suggests that women in science deny the existence of the gendered processes and power differentials altogether as a way of resistance (Benkert, Staberg, 2000) or, alternatively, adopt male values and practices as a strategy to survive or thrive (Lewis, Humbert 2010). Once again, the STEM environment reflect the ideology of an ideal worker who has no family commitments (Rapoport et al. 2002). A critical mass of women scientists in itself is not sufficient to bring about systemic change in organisations based on male values and practices (Glover, 2002). Nevertheless a critical mass of women in a range of organisations in various sectors tends to be associated with greater institutional pressure on employers to introduce policies on work-life balance (den Dulk, van Doorne-Huiskes, 2007), which may be a necessary first step in challenging male structures, cultures and practices. When studying women in science, Xie and Shauman (2003) found that most of the observed sex differences in research productivity and alike could be attributed to demographic characteristics and, most importantly, the structural features of the employment setting. Below some key data for understanding the European context is provided.

Gender and organizational culture in research: European data

- ***For many years, women in the EU-28 have been significantly under-represented in research & innovation outputs (She Figures 2015, see also Beede et al. 2011)***
- Under-representation is particularly severe in 'innovation' (patent applications for inventions), rather than in 'research' (scientific publications): since 31% of publications had a woman corresponding author between 2011 and 2013, whilst a mere 8.9% of patent applications registered a woman inventor (2010-2013) for EU-28 (She Figures 2015)
- The proportion of scientific publications by women corresponding authors slowly increased in the EU-28 between 2007 and 2013, including in engineering and technology (CAGR (Compound Average Growth Rate) at 3.9%). A similar increase was observed for inventorships (with an increase of 2.2% from 2002 to 2013, She Figures 2015)
- At EU-28 level, women and men corresponding authors publish their scientific papers in comparably influential journals. Though fewer scientific publications' first authorship is attributed to women than men, on average they publish their results in journals of equivalent prestige (She Figures 2015)
- The gender gap in the funding success rate at the EU-28 level is slowly declining, though the success rate for men is still higher than that for women in 70% of countries (She Figures 2015)
- Between 2010 and 2013 in the EU-28, the proportion of scientific publications with a gender dimension ranged from virtually zero in agricultural sciences, engineering and technology, and natural sciences to 6.2% in the social sciences. This further excludes or marginalizes women in these disciplines (She Figures 2015).

1. Gender stereotyping and bias across the life-course

Different views upon the explanations of women's paucity in the role of scientists contain also the issues of cultural misrepresentation. Of all the sciences in many countries, including the leading economies, physics continues to have the lowest representation of women. While small improvements have been made and female physicists “could be the majority in some hypothetical future yet still in their careers experience problems that stem from often unconscious bias” (Ivie, Tesfaye 2012). Luckily, it is now recognized that biases “function at many levels within science including funding allocation, employment, publication, and general research directions” (Lortie et al. 2007:1247; see also Cunningham 2013; Eccles et al 1990; Ivie, White 2015).

a. Young girls and science

As early as at the beginning of 1980s, the biological explications of gender differences were somewhat rejected and rebutted. For instance, Saraga and Griffiths claimed in 1981 that “the relationship of girls to science, and their performance in it, are too complex to be understood in terms of one factor, but that several factors must be integrated in a broader understanding of the social context in which science is carried out, and in which socialization takes place. (…) Theories couched in biological terms cannot be sustained. (…) it is not sufficient just to consider the development of girls in relation to science—the development and practice of science must also be discussed” (1981: 85). However, the arguments that nevertheless allude to biological sex rather than cultural gender continue to be put forward (e.g. Halpern et al. 2007). Very recently, Ceci and Williams debated a mixed-approach to career preferences, adopting a framework that focuses on adolescent girls' selection of careers related to people rather than things (2014). According to the authors, preferences account for burgeoning numbers of girls in such fields as medicine and biology, concurrent to weaker presence in math-intensive fields like computer science, physics, engineering, chemistry, and mathematics. This helped understanding that preference prevail in choices, even when math ability of girls and boys is equated (Ceci, Williams, 2014).

Quite clearly, girls are at the centre of cultural causes of later absence in science, which were linked to the missing female role-models, and the constructions of girlhood that are far removed from interest in science, gathering positive experiences from contact with science, as well as irrelevancy of science curricula built around cars, machines, vehicles etc. for young girls. As argued by Lewis and Humbert (2010) from the early age science-derived role-models for girls are rare, while cultural pressures exerted on girls to conform to traditional gender roles that exclude a scientific career run high (Blickenstaff, 2005). Williams and Ceci (2012:139) bring about explanations from some scholars about the effects of early socialization practices that end up in girls and women dropping out of math-based endeavours or change their focus. Arguments about early-life segregation of toys and slogans, then translate into uneven treatment by middle-school already. More specifically, “Barbie dolls proclaiming “Math class is tough,” middle-school math teachers calling on boys more than girls” in high-school urge girls to be cheerleaders or writers instead of scientists.

According to Betz and Sekaquaptewa (2012), women in STEM are often labelled as unfeminine, which is a costly social categorization conducive to dropping out from these fields despite talent and interest. At the same time, studies conducted with middle-school girls by the authors suggest that inclusion of female STEM role models who are counter-sterotypic-yet-feminine led to no success among young girls. These results did not extend to feminine role models displaying general (not STEM-specific) school success, indicating that feminine cues were not driving negative outcomes. All STEM-de-identified girls considered a successful combination of femininity and success highly unlikely, thusly calling for better-suited campaigns at this level (see also Neuschatz, MacFarling 2003).

In that sense, it is important to note that Dabney and Tai (2013) found that female physicists report the significance of both early and long-term support outside of schooling. Such assistance and encouragement offered by family was seen as essential to their persistence within the field. A greater focus on informal and out-of-school science activities for girls and young women should therefore be envisioned, especially those that involve family members. Interventions at the early-life and parents-inclusive in nature, may impact entrance into a physics career later in life. For female respondents in this study, entrance into physics occurred through encouragement, support, hobbies, and shared interests with their parents and family, thus signalling the importance of early interest in science and participation in unstructured science activities.

b. Bias among students and academics

Gender stereotyping continues at the later career-stages, wherein conscious and subconscious biases eliminate or decrease women's chances. Pursuing postgraduate education is a first step in the career of many - male or female - researchers. In 2012, the European Commission warned that “while the proportion of women at the first two levels of tertiary education is higher than that of men, the proportion of women at the PhD level is lower” (European Commission, 2012: 35). In line with the regional and Europe-wide ambition to encourage more 'research-intensive' economies, a call has been issued to attract more doctoral candidates. In addition, it was argued that efforts must be made to tackle “stereotyping and the barriers still faced by women in reaching the highest levels in post-graduate education and research” (European Commission, 2011: 5; EC 2015: 20). However, the lack of female career models in early-life continues throughout education and is also said to contribute to women leaving sciences and opting out from pursuits of advanced (postgraduate and doctoral) degrees.

The pattern is exacerbated by the persistent unavailability of female scientists who were also fulfilled as mothers (Mason et al. 2013; Wolfinger et al, 2010). What is more, Whitelegg and colleagues (2002) argued that while the overall levels of harassment reported by female physicists is low, older male in the discipline (aged over 55) were perceived as having stereotyped attitudes to younger women postgraduates and employees. This views were named as a barrier to career progression for women.

c. Consequences of stereotyping

Gender stereotypes do not operate in a vacuum, but are rather strongly linked with consequent choices to stay or leave academic research, particularly for female physicists (e.g. Newsome, 2010; Giles et al. 2009; Godfroy, Genin 2009; Hodgson et al. 2000).

During a longitudinal 5-year survey of the perceptions of problems for women and men in the fields of science, math, and engineering among undergraduates, Hartman and Hartman (2008) identified little significance of exposure towards female role models in the fields among young women. This may suggest that, by the time that students have already made major choices career-wise. Further, exposure to professional experiences reduced the perception of problems in the field, especially alleviating the negative outlook for women. Working outside of academia related to women's intentions to persist in the field after graduation, yet effectively reduced a potential to take on academic track. This coincides with Newsome's findings on young chemists in the UK, where only 12% of third year female PhD candidates wanted to pursue a career in academe, compared to 21% of men. Newsome reports that female participants in the study described the obstacles they faced in doctoral study and wished not to continue in their future careers. These features encompassed lack of mentorship, feelings of isolation and exclusion (particularly within research groups), discomfort with the masculinist culture of research environment, and apprehensions that poor (though statistically average) experimental success rates would reflect negatively on their competence (the “Prove-it-Again” pattern). What is more, women perceived science research careers as “too all- consuming, too solitary and not sufficiently collaborative,” incompatible with their relationship and family goals, as well as demanding sacrifices they were not willing to make (related to femininity and motherhood).

Further, there was a meta-finding that women realized that these fields are biased against them and decided not to engage in an unequal fight against bias (Newsome, 2010), so by then the damage of bias has been done and irreversible. In another study, however, Smelding's (2012) underlines that implicit gender stereotyping was not related to math performance for female engineering students, unlike for women in other disciplines (see also Nosek et al. 2002). In other words, the work on stereotyping is promising in fostering bias-avoidance, because otherwise present strong implicit gender stereotypes are directly linked to discriminatory behaviours in the workplace. Such work, however, must target men and women across the disciplines to alleviate societal prejudice more generally.

Still, evidence about bias and discrimination for women in STEM has been mixed, and conventional explanations are often given as the pull of children and early-on life-choices against pursuing careers in math and science (Moss-Racusin et al. 2012). On the one hand, some studies conclude with quantity-not-quality-driven explanations: the relatively low percentage of women stems from fertility and preference factors, which cannot be seen as “caused by discrimination” in STEM (Ceci et al. 2009, 2011; Ceci & Williams, 2014).

On the other hand, recent studies equally propose that gender bias is to blame (Williams et al 2014). For instance, one project discovered that even when math skills were identical, both men and women were twice as likely to hire a man for a job that required math (Reuben et al. 2014); the bias reached up to 90% level for mistakes occurring in favour of men. Another study yielded a discovery that in academic laboratories in elite universities, male (but not female) scientists employed fewer female than male graduate students and post docs (Sheltzer & Smith, 2014). Finally, Moss-Racusin et al. (2012) used a double-blind randomized design to examine bias of science faculty through random assignment of male versus female name to an application for a post. The authors discovered that both male and female research and teaching faculty exhibited a bias against female undergraduate students, evaluating them as less competent, hireable, and qualified, and offering them less funding and mentorship. For example, based on application materials, a candidate for a laboratory manager position was deemed more competent, qualified, and hireable if they had a male name. The authors call for a conscious intervention that addresses faculty gender biases: “The dearth of women within academic science reflects a significant wasted opportunity to benefit from the capabilities of our best potential scientists, whether male or female” (Moss-Racusin et al. 2012: 16478).

Even in the gender-more-progressive science fields, gender bias persists in hiring. Sheltzer and Smith (2014), for instance, demonstrated that elite male faculty in the life science employ fewer women, despite the fact that women receive more than one-half of the doctoral degrees in biology-related fields. They remain, nevertheless, drastically underrepresented among life science faculty. In this study, Jason M. Sheltzer and Joan C. Smith found that male faculty members tend to employ and train fewer female graduate students and postdoctoral researchers than their female faculty colleagues. Through analysis of publicly-available data on the composition of biology laboratories they found that “faculty members who are male train 10-40% fewer women in their laboratories relative to the number of women trained by other investigators.

Therefore, bias is often implicit or unintentional, “stemming from repeated exposure to pervasive cultural stereotypes that portray women as less competent but simultaneously emphasize their warmth and likability compared with men” (Racusin et al. 2012; see also Williams et al. 2014; Cunningham 2013)[2]. In a study of women of colour in science, Williams et al. (2014) revisit and build upon the classic 1976 study and cumulatively present the four main gender biases practices in STEM. The authors document patterns and review literature reflective of four distinct ways in which gender bias operates in sciences and academe. These are here expanded with further examples from various studies:

- Prove-it-Again: women need to provide comparably more evidence of competence in order to be seen as equally competent as men. This is a form of descriptive gender stereotyping which relies on a perceptions that women *do not fit* the science work culture, and that there is an incompliance between being a woman and being a scientist (Nosek et al. 2002; Moss-Racusin et al. 2012). Chesler et al. (2010: 1933), talking about the “pipeline still leaking”, argued that ”[s]ubstantial research shows that resumes and journal articles were rated lower by male and female reviewers when they were told the author was a woman; similarly, a study of postdoctoral fellowships awarded showed that female awardees needed substantially more publications to achieve the same competency rating as male awardees”. Hill, Corbett, Rose 2010: 24, Lortie et al. (2007) and Sheltzer and Smith (2009) also pointed out that “Prove-it-again” is salient in the processes of review and hiring, while Wenneras and Wold (1997) calculated that a female postdoctoral applicant needed to publish at least three more papers in

a prestigious science journal or an additional 20 papers in lesser-known specialty journals to be judged as productive as a male applicant. Conversely, certain regions witness some progress in this area, as reported finding from 1997 Wenneras and Wold study has not been repeated in their 2004 review, which found no bias in productivity assessment of female PIs in grant proposals.
- The Tightrope: women must navigate the perceptions of being seen as either overly feminine thus incompetent, or as too masculine to be meshing well with colleagues in a work environment and thus unlikeable (Cuddy et al 2004). This is a form of prescriptive stereotyping originating from the fact that science is seen as requiring masculine qualities, yet women are never expected to abandon their femininity by the broader society. Thus women often find themselves pressured to take on dead-end roles, from acting as administrative assistants to being expected to mentor everyone else's students in addition to their own (Williams et al. 2014). Even in masculinist environment, women face backlash for behaving in stereotypically masculine ways, such as being assertive (Prentice, & Carranza, 2002), angry (Brescoll & Uhlmann, 2008), or self-promoting (Rudman, 1998).
- The Maternal Wall: motherhood, discussed in detail earlier in this report, is by far the most damaging with regard to gender bias (Ivie et al. 2002; Mason, Goulden 2004; Ceci, Williams, 2009). This form of descriptive stereotyping depends on a belief that women's work commitment and competence disappear after they have children (Correll et al. 2007). What is more, there is an element of prescriptive stereotyping found here as well in a way that mothers who remain indisputably committed are penalized as well for not adhering to a cultural gender norm of maternal dedication (Benard & Correll, 2010).
- Tug of War: Sometimes gender bias against women fuels conflict among women. This stems from the fact that women as well as men are biased against women in traditionally masculine domains (e.g. Moss-Racusin et al, 2012). Studies show that women who experience discrimination early in their careers tend to distance themselves from other women (Derks et al. 201). Commonly this strategy is referred to as the “queen bee”.

In an academic world, Devis and Morrison (2009) see these areas as reflective of the long-standing gendered division of academic labour that sees women more concentrated in teaching activities while men focus on research and publishing (Bagilhole & White, 2003; Park, 1996); the tendency for women to experience less secure and less continuous employment (Allen & Castleman, 2001; Lundy & Warme, 1990; Sellers, 2007) and to have less confidence in their abilities or achievements and less access to academic networks (Britton, 1999; Deane, Johnson, Jones, & Lengkeek, 1996; Doherty & Manfredi, 2005); choice of discipline area (Bell & Bentley, 2005; Kirkpatrick, 1997); as well as work-life pressures (Forster, 2000; Probert, 2005).

Following an intersectional approach, Williams et al. (2014) have recently examined the “double jeopardy”, that is the binding of ethnicity and gender. Gender bias in laboratories exists, and it is prominent for women of colour: 100% of the sixty scientists interviewed for Williams et al.'s study (2014) reported encountering one or more patterns of gender bias and an earlier study found that 97% of the Black women interviewed were aware of negative stereotypes of Black women, while 80 percent had been personally affected by them (Jones & Shorter-Gooden, 2003). Women of colour face “double jeopardy” because they encounter race as well as gender bias and have the “bee” syndrome attributed to the personality problem of an individual woman, rather than a gender bias in the environment. Similarly, Malone and Barabino (2009) demonstrated how students of colour suffer from invisibility/lack of recognition, being in the loop, racialization, and the integration of their identities. The issues of race in the research laboratory complicates the already tenuous dialectic between the social and the individual implications of gender bias (see also Herzig 2004; Rosa, Mensah 2016).

In sum, bias continues further down the pipeline, as women become increasingly disenfranchised once they enter science careers in academia. Ceci and Williams (2014) remind women's accounts of a “chilly climate”, already mentioned by Newsome's respondents above (2010) and by Blickenstaff more broadly (2005). In the study of early-career female physicists in the UK by Whitelegg et al. (2002), gender bias seemingly functioned differently depending on the respondent's age. Different perceptions were expressed by younger and older women about gender-related barriers or constraints they have met in pursuit of their physics careers. In a survey of women at the Institute of Physics (IOP), only 15% of the younger women (aged under 30) said they had encountered gender barriers compared with 45% of older women.

Note, however, that the attrition among the young women remained high, with only one out of four remaining in science. Dislike of a “male culture” and “atmosphere” of physics research centres and departments was a commonly given reason for leaving academia. There was also a conviction that it is nearly impossible for a women to ever accomplish a senior physics post, which are in turn explained by the lack of options for balancing a research career with a young family, as well as women tending to follow their partners with moves, essentially removing themselves from physics community. Although young women often do not perceive these conditions as gender barriers, they certainly are notions stemming from bias that impede women's success in the field. Ivie and Ray confirmed the prevalence of “chilly climate for women in physics” ((2005: 21), stating that the atmosphere is tangible in the everyday work of female physicists who are often still told through actions rather than words that physics is a man's world. This unwelcoming cold-reception impacts upon unequal pay and promotion schemes; devaluing of women's work styles and biased assessment of their efforts and performance (Bronstein, Farnsworth, 1998), as well as persistence of old-boys' clubs that isolate women in a conscious or awareness-lacking manner.

2. Raising and assessing gender awareness

Global survey showed that female physicists are generally exposed to lesser access to resources and fewer opportunities to advance their careers (Ivie, Tesfaye 2012:51). Scientific community, in general, fails to acknowledge that allocation of resources, such as funding and lab space, that are needed to contribute to the scientific body of knowledge, are gender-dependant.

As one example, Cotta et al. (2009) discuss how the main Brazilian funding agencies, CNP and CAPES, have introduced gender awareness projects in recent years. This initiative is a starting point for changing the percentage of women at all career levels in physics, but particularly at the top. Thus far, captured change has been mild and the most likely reason is that the decision committees consist mostly of male researchers. In spite of program's implementation, prejudice was still plaguing the evaluation process. Still, the average number of publications of the female researchers is 72% higher than for the male researchers at the entrance level, indicating that it is harder for women to enter into the research system.

Similarly, the European Research Area (ERA) Survey points the way to the actions that research organisations can take, such as recruitment and promotion measures, targets to ensure gender balance in recruitment committees, flexible career trajectories (e.g. schemes after career breaks), work-life balance measures and/or support for leadership development. According to the ERA Survey of 2014, around 36% of research performing organisations (RPOs) indicated that they had introduced gender equality plans in 2013 (EC 2015: 6) In 26 out of the 37 countries for which data are presented, more than half of the responding RPOs had work-life balance measures in place. However, targets for recruitment committees and support schemes for leadership were relatively unusual (in most countries, less than a quarter of RPOs had these measures in place in 2013) (EC 2015:100).

On a meta-level of fostering intra-discipline change, Phipps (2006) studied policy, activism, and educational activity around the issue of women's under-representation in science, engineering, and technology since the 1970s. She discovered that flourishing literature on gender and STEM rarely translates to inclusion of other than neoliberal feminist framework. More specifically, women in STEM were found unlikely to claim allegiance with feminism, and the field-activists have not tapped into solutions offered by critical, radical and postmodernism feminist perspectives to entice change. Phipps argued that the activists' 'feel for the game' incorporates a disposition towards reformism and 'neutrality' that relies in part on a dis-identification with feminism, this staggering the progress in the field.

3. Conclusions and Recommendations

- Cronin and Roger (1999) point out that initiatives to bring women and science together focus on one of three areas: (1) attracting women to science, (2) supporting women already in science, or (3) changing science to be more inclusive of women. All these initiatives are related to the prism of culture in the perception, practice and retention and, as such, need to be implemented together (Blickenstaff 2005)
- Almost all of the articles call for conscious, structured, institutional efforts to counteract unconscious and unintentional gender biases. (see also Savonnic, Williams, 2016). An exception is by Ceci et al. (2011), who claim that not everything should and needs to be explained with a bias framework. Although real “barriers are still faced by women in science, especially mathematical sciences, historic forms of discrimination cannot explain current underrepresentation”, meaning that redirection of resources should focus on current rather than historical causes of women's absence in STEM careers (ibid, 2011: 3158)
- In efforts to avoid women's and parents' exclusion, professional meetings should be scheduled in a way that does not collide with childcare responsibilities (e.g. during school hours) (Ceci et al. 2009). As one example, the UC-Berkeley's *Family Edge* program provides high-quality childcare and emergency backup care, summer camps and school break care, as well as offers re-entry postdocs. There and at some other institutions, usually at the top-level, the administration instructs committees to ignore family-related gaps in CVs. At the same time, as Ceci and Williams argue, more research into solutions is needed to assess their effects and promises (2011)
- Transparent schemes of salaries, bonuses and income incremental increases need to be implemented and, ideally, appropriately sensitive to career-breaks. Research in this realm should examine in more detail the connection between gender and job titles, and their entanglement with remuneration (Ivie, Ray 2005)
- Going beyond structured institutional support, Dabney and Tai (2013) additional suggest policy proposals around an indirect support system through peers and support groups for women in physics: “while women are often underrepresented in these programs, peer socialization and workshop activities can be developed to encourage the inclusion of women into these physics programs and departments as future faculty members. Finally, women support groups can be developed across university STEM based departments thereby providing female physicists a social network and critical mass of peers both within and outside of the university” (Hodgson et al. 2000). There is a paramount importance of the quality and availability of mentoring programs for new academicians (O'Laughlin, Bischoff, 2005).
- Drawing on subfield examples of good practices, more specifically positive gender experiences in Physics Education Research (Barthelemy Van Dusen, Henderson 2015)
- Awareness campaigns against stereotyping must target predominantly men (Smelding 2012), while awareness of bias and ways for dealing with systemically legitimized “boys clubs” should be made available to women (Whitelegg et al. 2002)

- Wynarczyk and Renner (2006) argued that WLB policies trump other STEM-specific barriers in holding back career development among women scientists. As an idea of an intervention, however, it needs to be contextualized because the gaps are noted across many sectoral and national contexts, then translating into policy and culture clashes science (Webster, 2005)
- Broadening the scope of gender inspirations is needed, as gender/STEM activist exhibit rehashing of the same ideas, conformism to established patterns, and, in result, miss opportunities for introducing novel measures (Phipps, 2006)
- According to Blickenstaff (2005), the amelioration of research cultural environment must begin at an early education level rather than try to mitigate the later challenges. She proposes to address the following recommendations:
    - ensure students have equal access to the teacher and classroom resources
    - create examples and assignments that emphasize the ways that science can improve the quality of life of living things
    - use cooperative groups in class, or at least avoid dividing students by sex for class competitions or in seating arrangements
    - eliminate sexist language and imagery in printed materials
    - do not tolerate sexist language or behavior in the classroom
    - increase depth and reduce breadth in introductory courses
    - openly acknowledge the political nature of scientific inquiry.
- Per Ceci and Williams, “one strategy to broaden girls' interests and aspirations involves providing them with realistic information about career opportunities (…). This intervention is not meant to dissuade girls from aspiring to be physicians, veterinarians, and biologists, fields in which women are becoming a majority, but rather to ensure they do not opt out of inorganic fields because of misinformation or stereotypes” (2009: 3161)
- For sparking and retaining interest in a career in physics in females, interventions and campaigns should not only begin as early as possible in childhood, but also incorporate parents as agents of persistent support and encouragement. Dabney and Tai (2013: 010115-7) argued that “a greater focus on informal and out-of-school science activities for females that incorporate family activities early in life may help influence their entrance into a physics career later in life. While these informal activities occurred within the home, they are not beyond the influence of education and public policy”
- Seemingly ideal is an approach going beyond the short-term remediation and specific policies to improve position of women as a first necessary step (Cockburn, 1989), yet focus on the longer agenda of working towards more systemic change and transformation to the masculinist ideals of science-employee that is assumed male and family-free (Lewis, Humbert, 2010; Bleijenbergh et.al., 2012)
- Racusin et al. (2012) as well as Castilla and Benard (2010) claim that disciplines that value “objectivity” are particularly susceptible to subtle gender biases because they are not on guard against them, unlike their colleagues in social sciences, for instance. The lack of awareness, however, does not mean that women's career decisions and whether they see doctoral studies in the sciences as a viable option is not affected. Thus, more gender-awareness trainings should generally be issued to faculty in sciences (Racusin et al.2012)
- Self-assurance of objectivism and meritocracy in STEM leads to tokenism, especially for women of colour in sciences. The conviction about being superiorly fair needs to revisited, especially for hiring committees and similar bodies (Williams et al. 2014)
- Awareness trainings must draw attention to equal distribution of “soft” and “hard” types of resources needed to advance a career in science, ranging from access to graduate students or employees to assist with research, to clerical support, research funding, and travel money. Gender-balance should be ensured within invitations to speak, serving on committees, and conducting research abroad (Ivie, Tefaye, 2015)
- Focus on productivity as number of publications might not be the best way moving forward in

reducing gender bias (Fox, 2005). The performance should be studied more in reference with levels of personal engagement with a research area, vibrancy of research environment, appropriate research infrastructure, enjoyment of the research process itself, quality feedback, and public recognition of achievements as factors likely to lead to enhanced research performance (Dever, Morrison, 2009:50; Acacio et al. 1996).

Examples of good practices:

University of York (United Kingdom). Equality Committee engaged in a review of student internship placements. In this realm, two issues were raised. First, the committee ensured that all employers benefitting from student interns embrace and obey Code of Conduct, thus limiting the scope for instances of gender discrimination, sexual harassment, etc. of female students. Secondly, placements were advertised to women in science - with the support from Athena Swan - and STEM internships increased the male/female ratio to 60/40.

University of Warwick (United Kingdom). As part of Gender Equality Objectives, data is collected on diversity among staff to ensure that needs of sexual minorities are accounted for.

Antwerp Charter On Gender-Sensitive Communication In And By Academic Institutions (Belgium): Signed by diverse institutions, the aim of the charter is to eliminate bias from all institutional communication, which may lead to perpetuating gender-based stereotypes. The institutions commit that in all diverse forms of institutional communication, through diverse channels and to diverse audience, they would promote, among others, gender-sensitive communication and unbiased portrait of women (http://eige.europa.eu/sites/default/files/egera_antwerp_charter_on_gender-sensitive_communication_in_and_by_academic_institutions.pdf).

National Girls Collaborative Project (USA). „The vision of the NGCP is to bring together organizations throughout the United States that are committed to informing and encouraging girls to pursue careers in science, technology, engineering, and mathematics (STEM).The goals of NGCP are to maximize access to shared resources within projects, and with public and private sector organizations and institutions interested in expanding girls' participation in STEM, to strengthen capacity of existing and evolving projects by sharing exemplary practice research and program models, outcomes, and products, as well as to use the leverage of a network and the collaboration of individual girl-serving STEM programs to create the tipping point for gender equity in STEM.
The project focus from 2011-2016 has been to:
1. Strengthen the capacity of girl-serving STEM programs to effectively reach and serve underrepresented girls in STEM.
2. Increase the effectiveness of Collaboratives by providing professional development focused on sustainability, organizational effectiveness, and shared leadership.
3. Maximize K-12 school counselors' access to and use of relevant, high-quality resources that increase awareness of barriers to girls' interest and engagement in STEM“ (https://ngcproject.org/about-ngcp).

next

[1]
The impact of stereotype threat on womens performance in physics is further examined by Marchand and Taasoobshirazi (2013), Eddy and Brownell (2016) and Kelly (2016

[2]
Gendered bias has been proven to be present in college students’ evaluations of their teachers. Both male and female students underrated their female high school physics teachers and students with a strong physics identity showed a larger gender bias in favor of male teachers than those with less of a

physics identity (Potvin, Hazari 2016).