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Dilemmas of girls and women in engineering: a study in Portugal

Luísa Saavedra^{a*}, Alexandra M. Araújo^b, Maria do Céu Taveira^a and Cristina C. Vieira^c

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The reason that girls and women withdraw from science and technology education and careers has been a universal concern in the social sciences. This study investigated how gendered constructions of identity are translated into the barriers and fears that female students and professional women experience in decision-making about their careers. We conducted interviews with 63 girls and 39 women in academic and professional engineering careers, focusing on their interpersonal relationships with boys and men in their school and occupational engineering settings, respectively. Participant discourse highlighted the difficulties women face when managing the antagonistic discourses of femininity and masculinity in a social environment in which they are frequently forced to submit to hegemonic masculinity. The consequences of women's differing discourses about the "masculine world" and the "feminine world" are discussed, and some strategies for creating more equalitarian relational environments in school and work settings are discussed.

Keywords: equality/inequality; identity; science/engineering; sex/gender

Introduction

Women remain underrepresented in scientific and technical careers, as well as in high-ranking leadership positions in government, business, the military and education, where men are still dominant (Betz 2005; Bouville 2008; Nogueira 2009). In Portugal, horizontal segregation in education is still severe, leading to a similar situation in the labour market. The most recent data from *Eurostat* (cf. European Commission 2012) show that in 2009, only 29% of Portuguese researchers were women, a number that has decreased since 2002, when women represented 30% of the graduates working in research. In addition, the proportion of women graduating in engineering as well as in the construction industry was merely 29.4%: thus, there are three men for every woman in this field (CIG 2011).

Nonetheless, considering that Portugal was under a dictatorial regime for five decades, which resulted in a 33.6% illiteracy rate, the country has since then rapidly overcome a situation of cultural impoverishment, which especially obstructed women's opportunities (INE 2002). Recently, Portugal has achieved a number of academic successes equal to those of other countries, suggesting that girls are doing better than boys in particular school subjects such as math (e.g. Saavedra 2001),

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which is a result that should be interpreted cautiously. According to the last report Programme for International Student Assessment (OCDE 2012, 74), “better performance in science or mathematics among girls, however, does not necessarily mean that girls want to pursue all types of science-related careers. In fact, careers in ‘engineering and computing’ still attract relatively few girls”. The young adolescents who participated in this international comparative study expressed career aspirations that may contribute to a decrease in the gender gap in science and engineering, as 45.5% of girls and 49.3% of boys aspire to be in science or engineering professions when they are 30 years old. However, gender stereotypes generally act as barriers to the persistence of such career aspirations, particularly for girls (Saavedra 2010; Vieira et al. 2011), who later shift to more traditional female domains, which are usually remunerated at a lower level and not as prestigious.

Such an asymmetry in the representation of women and men in science and engineering professional cultures is related, among other factors, to pressure to adapt to the social norms of what it is to be “feminine” and “masculine” (Wright 1996; Fondas 1997; Kvande 1999; Henwood 2000; Rasmussen 2004; Peterson 2010; Pravadelli 2010; Saavedra et al. 2011; Skelton 2012). Based on the idea that personality characteristics are stable, immutable and genetically determined, masculinity is generally associated with instrumentality, as opposed to femininity, which is linked to expressivity. Historically, this tradition has subsisted since Parsons and Bales (1955) presented men’s and women’s personalities as opposite poles. Several of the following studies have adopted this paradigm. Rocheblave-Spenlé (1964, as cited in Amâncio 1994) described emotional stability, dynamism, aggressiveness and personal determination as male characteristics, while women were depicted as possessing the opposite features, such as instability, passivity and submission. Broverman et al. (1972) also described men as having traits such as competence, rationality and assertiveness, while they described women with features that were more belittling, including being dependent, subjective, passive and illogical. More recently, Francis and Skelton (2005) reviewed the constructs of gender and achievement in education policy and found the same polarity between masculinity and femininity.

Conceptions of femininity and masculinity that are essentialist and opposing have influenced girls’ and boys’ educational and career planning and choices (Rasmussen 2004; Skelton 2012), as well as women’s and men’s behaviours in engineering and technology jobs (Kvande 1999; Peterson 2010). Differences in the traditionalism of women’s and men’s career choices are partially based on the idea that appropriate behaviour for women in the occupational world is to be emotional and empathic, to take care of others, to know how to listen to and attend to others’ needs, to be sensible and to focus on relationships and collaboration with others, while men are expected to be assertive, self-centred and in control of themselves and of the situation (Fondas 1997). Consequently, a job with strong female connotations, such as teaching primary students, is seen as inappropriate for men (Skelton 2012), while women tend to be estranged from science and technology professions, which are traditionally ascribed qualities that are attributed to men. Based on these socially constructed representations of professions, boys and men tend to be attracted to the “hard sciences” (Schiebinger 1999), such as physics and also to careers in technology and engineering (Rasmussen 2004). According to Wright (1996), work environments dominated by masculine ideals are characterised by observable self-confidence in technical and manual abilities, and such environments

are not favourable to women. Consequently, women in male-dominated environments are confronted with a double-bind¹ dilemma (Jamieson 1995; Peterson 2010) because being identified as technically competent is contradictory to being identified as feminine or as a woman. Moreover, when women adopt behaviours that are traditionally ascribed to men, they experience disapproval from their colleagues and superiors.

However, since the 1990s, authors such as Candace West and Don Zimmerman (1987), as well as Judith Butler (1990/2002), have questioned the prevailing theoretical perspectives that portray gender identity as a coherent, stable and internal unit. This article follows such a post-structuralist perspective on gender, which assumes that we do not have a gender but that we are always “doing” gender (West and Zimmerman 1987, 126), or that, as Butler said, “gender proves to be *performative* [...] gender is always a doing” (1990/2002, 33). Wendy Faulkner (2000) has empirically shown that thinking in engineering is usually dichotomous and hierarchical even when gender is not involved. She also explains three ways through which engineering dualism can be gendered: “gender differences” in the division of labour and work styles between men and women, “gendered symbols” and “professional identities” (Faulkner 2000, 761). She deconstructs dualisms (within, for instance, the technical-social, specialist-heterogeneous and abstract-concrete dimensions) and the hierarchies within each of them, proving that both sides of each dualism co-exist in engineering practice and that some of them can be gendered in a manner contrary to expectations.

Based on the identification of different perspectives on gender, gender identity and gender performativity, this study analyses how discourses on gender identity are used by girls and women in engineering to construct their identities in male-dominated environments that are marked by hegemonic masculinity (Connell 1995; Faulkner 2009; Muhr 2010). We aim to understand how these processes might cause adolescents and adults to withdraw from this educational and professional domain and highlight the consequences for the personal and working lives with an emphasis on a discourse in which “masculine identity” is essentially associated with men and “female identity” is associated with women.

Research methodology

The aim of this study was to explore the experiences of girls and women in masculine hegemonic careers in engineering. We interviewed 102 voluntary participants. We selected participants who were (i) young girls in elementary ($n = 22$) and secondary education programmes with physics and maths classes who explicitly aspired to an educational path in science or technology ($n = 20$); (ii) college women enrolled in engineering undergraduate programmes ($n = 20$); (iii) professional women who were either under 30 years old ($n = 21$) or over 40 years old ($n = 19$) and worked in engineering professions (e.g. civil, electronics, mechanics, chemistry, computer, metallurgic, industrial management and textile).

Sampling was accomplished using the snowball technique. This process has been useful in studying specific populations, particularly in qualitative, feminist studies (e.g. Dyke and Murphy 2006). The three identified groups were included in this study for three main reasons: (i) to assess how younger girls and women anticipate their transition to a male-dominated work environment (and whether this anticipation may lead to an avoidance of this environment when their career choices are

not yet crystallised); (ii) to understand how older women face this male-dominated social and work environment and whether, as young students, they were conscious of the reality they would be facing; (iii) to assess whether having more or less work experience (i.e. more or less time spent in a predominantly male work setting) has consequences for the way these women perceive barriers.

After informed consent was given by phone or email, face-to-face interviews with the participants were conducted by researchers trained in interviewing techniques, either at the students' schools and universities or at the professional women's homes or work environments. The interviews were audio recorded and transcribed verbatim.

The semi-structured interviews focused on the participants' experiences of interpersonal relationships in academic settings and in the work place. Of particular concern to the study were key questions about difficulties anticipated or experienced in the engineering field: young girls were asked whether they anticipated struggles and difficulties when entering an engineering university programme; college women were asked if they had any problems in their relationships with their colleagues; and professional women were asked about actual difficulties experienced in their academic and work environments. Based on their answers, we furthered discussed with the respondents the strategies they used to overcome such difficulties.

We adopted a qualitative, critical, exploratory approach in this study and used Foucaultian Discourse Analysis to analyse the data (Willig 1999, 2008). Discourse analysis emerged in psychology in 1987 as a critical perspective that was opposed to cognitive psychology (Potter and Whetherell 1987) and was later named "discursive psychology" (Edwards and Potter 1992). One of the essential assumptions of this perspective is that language is not a representation of pre-existing cognitive structures in our minds but is rather a means by which objects and experiences are constructed. From this point of view, studies should focus on the language through which we construct and negotiate meanings (Parker 1992, 1999; Willig 2008). Based on the assumption that there is not an objective perception of reality, analyses should focus on the way that each person assigns meanings to social categories and on the consequences of these meanings, which entail the consideration of speech and text as action orientations.

According to Foucault (1972, 49), "Discourses are practices that systematically form the objects of which they speak". Foucaultian discourse analysts focus on the positions of the subjects that discourses allow, as well as on the role of the discourse in the wider social processes of legitimation and power (Willig 1999, 2008). From a Foucauldian point of view, the dominant discourses that legitimate existing power relationships and social structures can be resisted or subverted through language that enables counter-discourses (Willig 2003). Accordingly, speakers are seen as active agents in the construction of the world.

In this study, the process of Foucauldian Discourse Analysis we used followed Carla Willig's (2008) six stages. We started by identifying the ways that the relationships between girls/women and boys/men in engineering schools and careers are constructed (discursive constructions). At this stage, the analysis corpus was carefully reviewed for similarities and differences in the way that the discursive object was portrayed. Similar material was grouped under the same discursive constructions, which resulted in the identification of four discursive constructions. We then tried to understand these various discursive constructions within the wider discourses of femininity and masculinity and to explore how these constructs

correspond with or present novelty with respect to existing discourses in the social sciences. In the next stage of this process, we examined the action orientations of the young girls' and the college and professional women's talk and we then studied the subject positions that the identified discourses contained. In the following stage of this work, we focused on the relationship between discourse and practice or, in other words, on what can be said and done by these respondents to create more emancipatory or regulatory/conventional environments. In the final stage of the analysis, we studied the consequences of taking various subject positions on the subjective experiences of these girls and women.

Results

After a careful reading of the interview transcripts, we were able to identify four discursive constructions regarding the way girls and women construct their identities in male-dominated environments, which are reflected in the ways that they talk about their relationships with their male and female colleagues. The four discursive constructions were "I've always gotten along better with boys", "We women stick together", "It doesn't matter" and "So many boys can be a little bit complicated". We will present these discursive constructions and situate them within wider discourses on femininity and masculinity. The four remaining phases of analysis will be presented in the discussion of the results, where we will consider the need to confront several discursive constructions and the consequences of the discourses on actions, positioning, practices and subjectivities.

"I've always gotten along better with boys": female identification with the male norm

This discourse was present in all participant groups except for the ninth grade group and was the most frequently used discursive construction when discussing relationships between women and men in school and at work. In general, relationships with boys or men were construed as being easier and, therefore, more desirable:

I think I would adjust more easily if there were a lot more boys than if there were a lot more girls (student of computer engineering, 5²)

The participating girls and women offered several reasons to explain this preference and to justify that they felt better in an environment mainly composed of men. An emphasis on "female characteristics" and "male characteristics" was present in the following discourses, which shows that the respondents adopted a gender identity in confrontation with their own sex:

For me, it is easier with men ... it's easier in environments where there are men, maybe because there is also a more rational side in me, more yang, isn't it? More ... as it is, and I think that I have that rational way of thinking, more masculine, isn't it? (industrial management engineer, 39 years old, 8)

No, because I never had a great affinity with really feminine issues [Laugh]. I never was one of those people who would highly adapt to feminine activities, I always, maybe, liked more masculine stuff and maybe because of that, it wasn't a problem at that moment (student of physics engineering, 17)

Family and proximal contexts seem to be other reasons for this preference for being near boys and men:

I grew up in a small town and I was mostly surrounded by boys, rather than by girls (student of mechanics engineering, 15)

I'm the eldest, but essentially the person with whom I spent more time and identified myself more with, was my brother, so I've always been more attracted to ... Although I don't picture myself as a tomboy, I've always had some kind of preference to work with and live with ... more with the masculine side, although also with the feminine (civil engineer, 42 years old, 17)

These girls and young women describe boys and men as more authentic (student of computer engineering, 12), less complicated, calmer (student of materials engineering, 1) and less quarrelsome than their female counterparts. Feminine characteristics are described in a biased way based on recollections of experiences from secondary school in which the respondents' peer groups were already mainly composed of boys due to their choosing to study physics, which is a school pre-requisite for engineering programmes, as stated by a student of civil engineering: "But when I was in 12th grade, my class was almost only boys and I was ... we were two girls, I was already somewhat used to it". The same idea was present in the discursive constructions of professional women:

Well, at the moment I am working with some women and it hasn't been bad, but I've always had this belief that working with men is better; that old story that women are very conspiratorial and contribute to a really complicated work atmosphere. (civil engineer, 25 years old, 14)

Because we, even at school, we have more computer teachers that are men than women and I personally prefer to work with men than with women and I think that it's wonderful to work with men. (computer engineer, 31 years old, 19)

Thus, the discursive construction "I've always gotten along better with boys" seems to be supported by personal theories that advocate the existence of differences between men and women and that present characteristics ascribed to men as positive and characteristics ascribed to women as negative (Parson and Bales 1955; Broverman et al. 1972). This discursive construction is based on the following fundamental theoretical assumptions: (1) personality characteristics and traces are stable and internal; (2) there are associations between instrumentality, masculinity and men and between expressivity, femininity and women (Morawski 1987; Lorenzi-Cioldi 1988); (3) female characteristics are negative and masculine characteristics are positive. Taken together, these ideas seem to interfere with the possibility of a woman with "female characteristics" following a "masculine" course, which makes women feel that they need to identify themselves with men and with their characteristics and withdraw from being feminine.

"We women stick together": women's identification with their own group

This type of discursive construction was presented by four of the college women (who described themselves as being well-adjusted to their programme and classes) and one girl in ninth grade. These young women explained their good relationships

with their colleagues as being due to their classes and programme being mainly composed of men. For these young women, that there are only a few classmates of their own gender in their classes facilitates stronger group cohesion and greater identification among them:

I only knew one person who attended this Faculty; because there were only a few girls, we tended to gather a little more in the beginning, but at the moment there isn't that much of a separation from guys anymore. (student of computer engineering, 7)

It didn't frighten me at all, because we were 10 girls out of 100 and we really bonded at once and that really helped. (student of computer engineering, 11)

The only ninth grade student who used this discourse category already anticipated a greater closeness to girls:

I think that at the beginning, if I wasn't acquainted with other people, I would feel a bit different. I think I would try to make friends with the few existing girls and then, throughout the weeks, months, I would become friends with boys as much as with girls. (ninth grade student, 16)

In addition, one of the respondents who believed that bonding with girls is easier because the class is mostly composed of men reinforced this idea by mentioning the "evident" differences between boys and girls. In her response, we can find an affirmative attitude towards women in a male environment; in some cases, we observe that when girls are in the minority with respect to boys, they feel that they should not expose their femininity fully. Instead, this young woman adopted an attitude of self-affirmation when faced with a situation in which boys were the majority, suggesting a belief that girls have positive characteristics that are not present in boys: "Of course, even because they can see in us characteristics that they don't have" (student of computer engineering, 11).

This discourse accentuates the need to be close to individuals of the same sex (in this case, girls) because of greater identification and better relationships among them than with the opposite sex. Such a perspective seems to resonate an association between sex and gender (Butler 1990/2002). However, this perspective introduces a new dimension, which is closer to the standpoint of the feminist perspective (Harding 1986) of "valuing differences", as defended by Carol Gilligan in "In a Different Voice" (1982). Contrary to previous theories, this perspective accepts that women and men have distinctive features and seeks to support superior feminine qualities.

"It doesn't matter": women's lack of interest in relational experiences

Within the discursive construction "it doesn't matter", girls and women seem to view being in an environment mostly composed of men as something "normal". They do not have any preference for working with men (as in the first discourse) and they do not think that boys are better than girls; instead, they demonstrate a feeling of indifference. This discourse was exhibited by ninth grade students ("I have now really decided what to study and working with men isn't something that concerns me", student, 9), university students and working women. It can also be observed in students who came from a background in which they already had close relationships with boys, as described by some college students:

It didn't matter, because since I was a child I always got along a lot more with boys than with girls. In my school, there were six girls out of 28 students In my group of friends in my neighbourhood, there were three girls in a group of about 30 people. So, I didn't notice any difference. (student of civil engineering, 13)

Compared with other respondents in this study, the respondents who used this discursive construction did not mention that their school environment was mostly composed of men, as it did not seem to concern them in making their vocational choice. These girls and women said they never thought about this and that this issue did not matter when they chose the university undergraduate programme they presently attend ("I didn't even think about it and I think that it didn't make the difference to me, it passed right through me", student of geological engineering, 18; "It was, it continued to be unimportant. No, I don't have any problem", student of civil engineering, 20).

Professional women also used this discursive construction when they retrospectively analysed their career decisions: "At that time, I didn't even think about it, I didn't have that kind of Well, it didn't really influence my decision" (civil engineer, 49 years old, 19).

These girls and women seemed to present behaviours that, in terms of discourse analysis, are diffuse and to give responses that may translate, on the one hand, to a disinterest in personal relationships and, on the other hand, to a more or less conscious attitude of avoiding situations that may lead to discomfort.

One of the main differences between this discursive construction and the previous one is that, in this construction, the college women did not describe preferences for relationships with boys or the positive characteristics of boys (as in the discourse "I've always got along better with boys") and they did not mention the more positive characteristics of girls, as some of their peers did in the second discourse "We women stick together".

"So many boys can be a little bit complicated": women's fears in male-dominated environments

Although the majority of the younger students who participated in the study (ninth grade students) did distribute their responses among the three previous discourse categories, some of the respondents suggested a certain level of discomfort and uneasiness in the presence of a masculine-dominated environment, as shown in the following excerpts. The first transcript seems to point to some discomfort regarding these young women's bodies, as they felt that they are an observational target for boys: "I also think that it must be a little ... to be there with only boys ... she goes in front of the class and there are all those boys looking at her" (ninth grade student, 1).

However, when a ninth grade participant (5) said, "It can be frustrating to be only with the opposite sex and not understand that very well ...", she seemed to focus on the difficulty of being understood, in terms of her feelings and ideas, by her male colleagues. To at least have some female colleagues could be an advantage, as another participant stressed: "Maybe a little bit unpleasant if I were the only one [laughs] in the middle of so many people, maybe a little, but, for example, if there were more – three or four – it wouldn't be so bad ..." (ninth grade student, 10).

Whatever the reason underlying this uneasiness, these participants would most likely adopt the same discourse as “we women stick together” when entering a university programme in a male-dominated culture. Because these young women had not already made their minds up about college and were undecided about their future training, this perceived discomfort may lead to withdrawal from science and technology programmes and careers and should therefore be seriously addressed in educational and career counselling.

Discussion

The discursive constructions adopted by the girls and women who participated in this study express different ways of presenting interpersonal relationships and are immersed in more global, socially constructed discourses about male and female characteristics, which are depicted as essentialist and opposite. These discursive constructions were adopted by all the interviewed girls and women, regardless of their ages and academic statuses. This result suggests that active professional women, even the older ones, in their past, resorted to the same discourses that are used at the moment to explain their experiences as young women. Such a result indicates that there has not been a significant change in gendered discourses, suggesting that post-structuralist perspectives on gender have not been entirely successful in non-academic social environments; that is, they have not been pervasive in the social discourse of daily life. The discourse analysis we presented points to similarities as well as differences in the discourses of the different age groups included in this study.

The four discursive constructions of gender and gender in a relational context also mirror different ways of constructing women’s groups and men’s groups (Tajfel and Turner 1986; Amâncio and Oliveira 2006) and have different consequences for female action orientations, practices and subjectivities (Willig 2008). The discursive constructions “I’ve always got along better with boys”, “We women stick together” and “So many boys can be a little bit complicated” have different impacts on college women’s and working women’s positioning towards male colleagues, as well as towards themselves and on the possibilities for emancipation and fighting against discrimination. It seems that these two discursive constructions entail distinct meanings of being a woman in science and engineering: the first seems to allow girls and women to identify themselves with their male colleagues, while the second and third allow identification with female colleagues. According to Tajfel and Turner (1986), each individual seeks a positive social identity, based on a comparison between their own group (in this case, girls and women) and “the other” group (boys and men). Based on the theory of these authors, we are compelled to think that, in terms of subjectivity, the young girls and women that used the first discourse were not satisfied with their own social group (as they present women very negatively) and that the strategy they adopted to maintain a positive identity was to join the more valued group, in this case, men. However, at certain moments, this positioning may lead them to feel unsatisfied with themselves and that they do not belong to the male group. Based on the negative view these women had of their own sex, they are likely to highlight the attitudes and behaviours they consider to be masculine, or, in other words, closer to a “masculine identity construction”, ridiculing themselves of their “feminine” features. Regarding their action orientations, as they physically deviate from their colleagues, these college women are likely to

miss the opportunity to find common points of interest with other women and empowerment on a group and personal level concerning, namely the discrimination issues they face. Instead of compromising by changing aspects of their own gender's social group, they choose to join "the other" group and see them as their own social unit. These women's emancipation action is, therefore, repressed and they will most likely face some difficulties in their future careers, as they experience disapproval from colleagues and superiors for adopting masculine characteristics (Peterson 2010). We may conclude that this action orientation's function is to defend these girls and women against a negative self-perception and to confer the benefits of identification with hegemonic masculinity (Connell 1995) and the dominant group.

The second and third discursive constructs, however, seem to evidence a major and positive identification of respondents with their own group. These discourses may more easily allow for the development of a positive perspective about women (e.g. identifying positive characteristics about their own group) and of a closeness with their female colleagues for support when confronted with less pleasant situations presented by their male colleagues or teachers. However, in contrast, these women are more likely to adopt "feminine" behaviours in their occupational future and therefore experience less self-confidence than their colleagues. The probability of criticism from colleagues and superiors is minor because these women do not present themselves as a threat to male power and leadership (Peterson 2010). Basically, these two discourses seem to allow for greater inter-group well-being, although this is due to a disregard for personal satisfaction in light of maintaining gender normativity and not questioning hegemonic masculinity (Connell 1995).

The discursive construction "it doesn't matter" shows an attitude of avoidance towards confronting the situation of being a minority in a male-dominated environment. This may be a defensive attitude, as these women do not seem to want to face this difficulty. Therefore, concerning subjectivity, this discursive construction will most likely place these women in a more fragile position, although it may well allow them to face girls/women and boys/men in a less essentialist manner. When we started to analyse the interviews, we noticed that this was an issue that deserved deeper study. However, some attempts by the interviewers to delve deeper into the issue resulted in laconic responses, indicating a desire to avoid this topic. The purpose of this discursive construction seems to be to postpone a clearer positioning about gender or to simply deny the structural role that gender plays in social and professional relationships.

The discursive construction "so many boys can be a little bit complicated" warrants further analysis, as it was presented only by the youngest participants in this study. This discourse may be a product of the girls' present developmental stage, one in which they are in greater need, compared to the other participants, of a same-sex group in order to construct their gender identity (Sprinthall and Collins 1994; Kovacs, Parker, and Hoffman 1996). In terms of bias, such a discursive construction of identity in a relational context reflects fear and insecurity in male-dominated professions and will most likely result in avoidance of these fields of knowledge, as it was used by girls who have not chosen this area yet. At the same time, because this discursive construction is used by high achievers in pre-engineering classes, it seems to lead to a castration or circumscription of their career choices.

Taken together, these discourses highlight the ways that women feel in a particularly difficult situation, as they construct their selves to be either more similar to

men and less visible as women (Kvande 1999) or more similar to women and less competent as professionals. They are thus faced with a double-bind (Peterson 2010), which, as the word itself implies, has no solution. We end this section by reinforcing the idea that in all of the discourses analysed in this study and as Judith Butler (1990/2002) stressed, women seem to struggle for a sense of coherence and continuity in personality and identity between their sex, their gender and their sexuality. A greater awareness that identities are not internal and stable but, instead, “accomplishments” or “situated behaviours” performed in interactional or institutional arenas, would allow these respondents to act upon other types of discourses and share in different and more emancipatory negotiations of their positioning and subjectivities.

Conclusion

The “double-binds” (Peterson 2010) that girls and women face in science and technology are mainly due to discourses that conceive of female and male genders as opposite poles. These conceptions of gender have been questioned by the feminist literature for many reasons. One of these reasons is that dualisms are always hierarchical and usually position women at a disadvantage (Scott 1990) in describing the feminine as the negation of the masculine (Amâncio and Oliveira 2006; Faulkner 2000). In addition, the apparent gender differences between women and men translate into effective inequalities because discourses performatively construct reality (Butler 1990/2002). This study reinforces the idea that “there is no gender identity behind the expressions of gender; that identity is performatively constituted by the very “expressions” that are said to be its results” (Butler 1990/2002, 33). Moreover, the study also suggests the need to demonstrate that if gender is a doing, then it might also be undone, as might be the social discourses and institutions that support it (Deutsch 2007). Therefore, new discourses are needed in schools and occupational settings in which women are leaders or in numerical minority situations. The concept of *doing gender* (West and Zimmerman 1987) or of gender as a set of *performances* by which people present themselves to each other and construct their subjectivities (Butler 1990/2002) may allow greater flexibility and plasticity in boys’, girls’, men’s and women’s positions. Due to the nature of gender as a social and individual construct, gender is continually constructed and negotiated through interpersonal relationships that depend on cultural contexts.

According to this perspective, it is not surprising to see that discourses on gender are so evident in higher education programmes that are symbolically marked by hegemonic masculinity, as well as in the institutions in which these programmes are run. To confront “this reality”, it is important that girls who attend these programmes are able to apply discourses in which gender becomes visible in a *performative* way and is actively built on the interpersonal relationships of male and female colleagues. However, this shift will only become a reality when schools (teachers and male and female students) and families deconstruct beliefs, myths and gender dualisms and promote unbounded career choices for young people. Schools, as Mac and Ghail (2010) stated, are special places where alternative and non-hegemonic discourses are possible. New and non-dominant discourses might lead to a greater number of girls in technology fields, as well as to a reduction in the fear associated with this choice that was evidenced in the discourse “so many boys can be a little bit complicated”. Mothers and fathers should be shown their

relevant role in their children's educational and career planning and decision-making, particularly through the ways that they reproduce discourses about what is socially appropriate for girls and for boys (Bryant, Zvonkovic, and Reynolds 2006; Saavedra et al. 2011; Gunderson, Ramirez, Levine, and Beilock 2012). Educators, including teachers, also need to re-construct their discourses, acknowledging the power of discourse in the construction of new realities (Willig 1999). Consequently, interventions should aim to help teachers change their discourses and recognise uneven expectations for their students' success as well as the existence of a hidden curriculum in schools. Above all, it is essential that teachers develop a productive attitude towards gender issues (Gunderson et al. 2012), which will translate in structural and organisational changes in school culture (Saavedra, Taveira, and Silva 2010), resulting in a more egalitarian education for girls and boys and women and men. Resorting to research-action as a methodology in teaching, mainly in science courses, is important to fostering such an egalitarian environment, as expressed in the extensive work of Brenda Capobianco (e.g. Capobianco and Feldman 2010).

In addition, universities and other higher education settings should recognise their role in the persistence of these discourses that lead to women's invisibility, through the use of the "masculine plural" by teachers and the ways that courses are taught, among many other factors. Universities and other higher education organisations would benefit from discussion groups in which female students acknowledge and debate future struggles that they will most likely face in their transition into the labour market. Such an intervention would contribute to the definition of collective strategies for diminishing female students' evasion of technology careers, particularly regarding future plans for earning PhDs or getting promoted.

Finally, emphasising gender's *performativity* in different contexts is a strong strategy for overcoming dualism and essentialism. This dualism locks men and women into behaviours that compromise them personally and socially and sustain inequalities in access to education and work. This dualism also impacts the image that women put forth in occupational settings, thus interfering with girls' and women's access to and progression in professional domains in which men are numerically advantaged (European Commission 2009; Watts 2009; Eurydice 2010). However, society will also benefit from institutional changes, including the enactment of affirmative action, the requirement of equality in payment, the recognition of women's leadership skills and the establishment of family-friendly workplace policies. Although 30 years of feminist research and debate have led to little change in women's representation in science and technology fields, a global call for "undoing gender" in social interactions (Deutsch, 2007) will likely reduce gender inequalities in these domains. As Martin Mills and Amanda Keddie (2010, 413) have stated, there is still much for "feminists to be concerned about in western countries", including the prevailing inequalities in the educational and career opportunities of girls and boys and women and men in science and technology.

Notes

1. A double bind is an unsolved dilemma that can happen in communication when an individual (or a group) receives two or more conflicting messages, or in a situation in which a person must choose between equally unsatisfactory alternatives. This term was coined by Bateson, Jackson, Haley, and Weakland in 1956.
2. The numbers identify the group to which each respondent belongs.

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