Feminist scientists: transformative ways of inhabiting scientific systems

Uzuri Albizu Mallea[1] 0000-0001-7998-0037
[1]University of the Basque Country, Vitoria-Gasteiz, Álava, Spain. 01012

Abstract: *This paper takes the voices of six feminist scientists as a means to interrogate systems of power within science. It begins by highlighting the social and historical locatedness of science and gender systems as well as processes by which they have mutually constructed each other. It then describes and situates some of the experiences and discourses collected through interviews with feminist scientists. Power is read as a constructive force, which argues for a centering of discourses and practices that confront and impact on the regulating norms of science systems. For this reason, six feminist scientists are approached as expert witnesses on feminist interventions in science.*
Keywords: *Science/Gender System; Agency; Identities; Feminist Science.*

Cientistas feministas: maneiras transformadoras de habitar sistemas científicos
Resumo: *O presente estudo se baseia nas experiências de seis cientistas feministas como forma de questionar os sistemas de poder na ciência. O estudo começa evidenciando o posicionamento social e histórico dos sistemas científicos e de gênero, do mesmo modo que demonstra a construção mútua de ambos processos. Seguidamente descreve e situa algumas experiências e discursos coletados por meio de entrevistas com as cientistas feministas. O poder é tido como uma força construtiva, o que incentiva o enfoque de discursos e práticas que confrontem e alterem as normas regulatórias atuais de sistemas científicos. Por esta razão, seis cientistas feministas são ouvidas como testemunhas expertas na intervenção feminista na ciência.*
Palavras-chave: *sistema ciência/gênero; agência; identidades; ciência feminista.*

Científicas feministas: formas transformadoras de habitar sistemas científicos
Resumen: *Este trabajo pretende acercar vivencias y discursos concernientes a la ciencia y el género de seis científicas feministas, y profundizar en los modos en los que tales experiencias y perspectivas afectan la praxis científica de estas mujeres. El escrito arranca explicando el carácter social e histórico de los sistemas científicos y de género, así como la mutua construcción de estos. Se concibe el poder como una fuerza productiva, además de represiva, lo cual incita a poner el foco en discursos y prácticas que confrontan (y, en ocasiones, alteran) las normas de género reguladoras de los sistemas científicos. Se da cuenta de ambas dimensiones, represiva y productiva, por medio de voces que conocen y confrontan las normas de género presentes en ciencia.*
Palabras-clave: *sistema ciencia/género; agencia; identidades; ciencia feminista.*

Introduction

"How much of the nature of science is bound up with the idea of masculinity?" The feminist physicist Evelyn Fox Keller asked herself this question in 1985 with the publication of *Reflections on Gender and Science* (Evelyn FOX KELLER, 1985, p. 3). She focused on two crucial moments in the history of Western science, Classical Greece and the early modern period, and analyzed the way philosophers of those times including Plato, Bacon and Descartes, among others, understood the relationship between mind and nature.

In Plato's philosophy the universe is composed of two opposite and, therefore, complementary worlds: the material and the ideal. For him, mind and nature are both material and ideal; and

the path to knowledge consisted of pursuing nature's logic, not its materiality, through the rational or ideal dimension of mind. Moreover, since knowledge implies the union of kindred essences, relationships between ideal dimensions of mind and nature need to be horizontal. He understands the relationship between scientists and their objects of knowledge as analogous to a masculine homoerotic relationship without physical consummation[1] (FOX KELLER, 1985, p. 22-24).

Two thousand years later, Francis Bacon rejected Plato's fragmentation of nature. For him, there was no rationality in nature and, hence, no point in talking about nature's ideal dimension. Moreover, he established a correspondence between the pairings mind/nature and male/female, describing mind as male, and nature as female. It was about time, he argued, to turn away from ideas and abstractions, and start paying attention to natural phenomena. However, knowledge demanded not only contemplation, but a degree of force. Seizing and interrogating nature was the only way to make her (*sic*) betray her secrets. Therefore, within Baconian thought, the only way to achieve knowledge was for the male mind to dominate female nature. He depicted this mastery not as tyranny, but on a "chaste and lawful marriage between mind and nature" (Genevieve LLOYD, 1984, p. 12-13).

As Bacon rejected the existence of rationality within nature, René Descartes denied the idea of a fragmented mind. In his thought, mind is unique and indivisible. Irrationality is therefore displaced from the mind to the body, and the body associated with nature. As the dichotomy rational/non-rational acquired a different meaning, the separation of mind and nature was internalized to a divided human self. Effectively, Cartesian thought divided the human being into two conflicting parts: the non-rational body and rational mind. As a result, the process of knowing became a process that pertained entirely to the mind. Knowing became a cognitive exercise, exempt from bodily incitements even including the senses and emotions. Furthermore, it became a solitary endeavor (LLOYD, 1984, p. 41-42).

Fox Keller (1985) concluded from this analysis that science has evolved as a social construct. In both Classical Greece and in the early modern period, science was radically conditioned by gender systems, even as it denied the body as a cognitive agent. In response, Keller raises an interesting question: how might an alternative (e.g. feminist) conception of society modify the conception of knowledge? Providing a full answer to this question is an enormous task, beyond the scope of a single paper. In this case, the focus is specifically on feminists' experiences of working in spaces where scientific knowledge is produced. On the basis of in-depth interviews with six female scientists, the paper looks at how these women's experiences and discourses have impacted on their scientific praxis. While not a complete answer to Keller's question, the interviews conducted do illustrate some ways in which the presence of feminists and feminism in science can affect how knowledge is produced and understood.

This paper is an exploratory study that makes up part of a wider project seeking to identify, rethink and transform gendered dynamics in mathematics education to promote equality and inclusivity. For this reason, all of the interviewees are mathematicians or from disciplines with a large mathematical component.

Five out of the six interviewees work as science lecturers and researchers at the University of the Basque Country (UPV/EHU),[2] which is a public university in the Autonomous Community of the Basque Country. Based on a smaller university in Bilbao, it expanded from 1980 and now has campuses in all three provinces of the autonomous community. It stands out as the region´s primary research institution, carrying out 90% of the region´s basic research.

The sixth interviewee is co-creator of an education association located in the same territory. The association's work consists of both reflecting on and acting upon the potential of feminism as a tool for scientific education. They work closely with the UPV/EHU, providing training to science teachers.

The paper delves into all six scientists' experiences and discourses regarding science and gender and attempts to analyze the effects that these experiences and discourses have on their practice of science.

1. The Science/Gender System

In the previous section science was depicted as a construct radically conditioned by gender systems. However, the influence is not unidirectional, but bidirectional; that is, "ideologies

[1] Sexual relations between two male citizens, and adult and a youth, was the most prestigious model in Athens at the time. This pederastic relationship had elements that evoked both balance and asymmetry: both participants were male and of comparable social standing, but there was an asymmetry in age, as well as in the distribution of sexual desire (the adult was the lover, and the youth was the beloved). Seeking to strengthen the symmetries and erase the imbalances, Plato designed an ideal relationship beyond traditional pederasty: a homoerotic relationship that would transmute any physical excitement into intellectual energy.

[2] Referencing the region of the Basque Country can create ambiguities. The term is used to refer to a historical region located in the western Pyrenees, straddling the border between France and Spain. Euskal Herria is the oldest documented name for the area, dating from the 16th century; a literal translation of the name would be "nation of the Basque language". The Basque Autonomous Community includes approximately half this area and is an administrative region recognized by the Spanish state. It includes the three provinces of Araba, Gipuzkoa and Bizkaia.

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of gender and science inform each other in their mutual construction" (FOX KELLER, 1985, p. 8). Returning to Cartesian thought may help visualize how science systems have historically conditioned gender systems.

When describing the human being as divided into body and mind, Descartes did not gender such division. Nor, when defining human bodies on a close analogy with machines, did he explicitly allude to gender. However, there already existed established correspondences between the pairings rational/non-rational and male/female. Thus, by linking rationality with mind and non-rationality with body, much more extreme stereotypes regarding masculinity and femininity were developed (Ángeles PERONA, 1995). Furthermore, the "body as a machine" discourse evolved into a depiction of the female body as a womb; that is, as a machine whose purpose consisted of giving birth to and taking care of children on mass (Silvia FEDERICI, 2004, p. 17).

Modern science assigned gender to both mental and physical tasks: female mental activity would consist of dealing with emotions and senses; female physical practices, on the other hand, would be limited to the reproduction of life. Such assignments had severe consequences in women's lives. The first statement precluded them "from any significant involvement in the collective endeavors of science" (LLOYD, 1984, p. 50). The second one made possible "the development of a new sexual division of labor, subjugating women's labor and women's reproductive function to the reproduction of the work-force" (FEDERICI, 2004, p. 12).

2. Science and gender as performance

All the above has significantly influenced the construction of scientist archetypes. Values specific to western cultures have also been key in their establishment and maintenance.

On the one hand, *rationalism* and *objectism* establish "a way of perceiving the world as if it were composed of discrete objects, able to be removed and abstracted, so to speak, from their context". Accordingly, "to decontextualize, in order to be able to generalize, is at the heart of western mathematics and science" (Alan BISHOP, 1990, p. 57). On the other hand, *power*, *control* and *progress* define many of the objectives of western science. Science is even understood as the central bond between society and progress. Gaining control (i. e. power) over both natural and social contexts is understood as a prerequisite in order for progress to take place (BISHOP, 1990).

This definition of science and its objectives leads to the establishment of a determined profile for science practitioners:

> A science that advertises itself by the promise of a cool and objective remove from the object of study selects for those individuals for whom such a promise provides emotional comfort. Similarly, I suggest that a science that promises power and the exercise of dominion over nature selects for those individuals for whom power and control are central concerns. (FOX KELLER, 1985, p. 124)

Thus, the modern scientist is shaped as an autonomous human being who operates without intention or purpose in a purely mechanical way. This depiction of the modern scientist has proved to be very fruitful as a means for shaping modern masculinity (FOX KELLER, 1985, p. 70). If we understand the doing of science as an expression of gender, and take into account that gender expressions build gender identities (Judith BUTLER, 1990), we can affirm that the performance of science has historically been a way of masculinizing bodies. We can moreover conclude that, when science is performed by an illegitimate body, such a body is likely to be punished:

> The tacit collective agreement to perform, produce, and sustain discrete and polar genders as cultural fictions is obscured by the credibility of those productions—and the punishments that attend not agreeing to believe in them. (BUTLER, 1990, p. 140)

As a result, performing science can be a problematic activity for women:

> In a science constructed around the naming of object (nature) as female and the parallel naming of subject (mind) as male, any scientist who happens to be a woman is confronted with an a priori contradiction in terms. This poses a critical problem of identity: any scientist who is not a man walks a path bounded on one side by inauthenticity and on the other by subversion. (…) Her alternative is to attempt a radical redefinition of terms. (FOX KELLER, 1985, p. 174)

Acknowledging the possibility of a radical redefinition of terms calls for a (re) conceptualization of power as both a repressive and liberating force:

> [Power] doesn't only weigh on us a force that says no, but traverses and produces things, it induces pleasure, forms knowledge, produces discourse. (…) Wherever there is power, there is also resistance. (Michael FOUCAULT, 1980, p. 119)

Subjects are named and renamed within science/gender systems, but not determined by them: they are able to negotiate the sociocultural discourses that attempt to construct or constitute its identity (David STINSON, 2013). This notion of bodies as agents leads to more dynamic

and flexible definitions of both gender and scientific identities. Rather than defining them as fixed positions, I conceive them as entirely dynamic processes; as practices that constantly constitute and modify themselves within plural contextual frameworks (Mari Luz ESTEBAN, 2009).

I understand science's masculine nature to be contingent, and, therefore, redefinable in feminist terms. Accordingly, from here on out, this paper draws on feminist epistemologies that have attempted to (de)construct and transform scientific systems by developing alternative ways of knowing, as well as by building new instruments of vision with which to look at knowledge.

3. Feminist epistemology

Epistemology is the branch of philosophy concerned with the study of the nature, methods and limitations of science (Eulalia PEREZ-SEDEÑO, 2006). Feminist epistemologies are based on the social nature of scientific knowledge, as well as on the rejection of the Cartesian subject, that is, the individual and abstract subject as the antinomy of the object. Hence, gender and other social categories have a central role in studies based on feminist epistemologies. In fact, they conceive knowledge itself as a gendered practice:

> Practitioners of feminist epistemology and philosophies of science argue that dominant knowledge practices place women in a disadvantaged position by (1) excluding them from inquiry, (2) denying them epistemic authority, (3) denigrating their "feminine" cognitive styles and modes of knowledge, (4) producing theories of women that represent them as inferior, deviant, or significant only in the ways they serve male interests, (5) producing theories of social phenomena that render women's activities and interests, or gendered power relations, invisible, and (6) producing knowledge (science and technology) that is not useful for people in subordinate positions, or that reinforces gender and other social hierarchies. (Elizabeth ANDERSON, 2020)

In order to delve into the root causes of this discrimination, feminist epistemologies problematize the subject of knowledge, the scientific method, and positivist values such as neutrality, objectivity, rationality or universality (ANDERSON, 2020).

The various currents that constitute feminist epistemologies share common denominators. Nevertheless, there also exist points of disagreement between them. Here I go into more detail by considering the two currents within feminist epistemology which have most influenced both the theoretical framework and methodological design of the present study: feminist standpoint theory and situated knowledges.

3.1. Feminist standpoint theory

Feminist standpoint theorists state that there is epistemic distance between knowers, and claim that a woman's standpoint is epistemically more valuable than a man's. This epistemic privilege is not simply a given, but attained collectively through a collective engagement with shared oppressions (ANDERSON, 2020). Given that women are marginalized subjects, a gaze coming from such subalternity is likely to be much more complex than perspectives that belong to socially privileged positions.

Feminist standpoint theorists therefore call for a shift in which marginalized perspectives are centered, in order not only to make women's experience visible in critical theory, but also to rethink history and even the natural world from women's perspective. By bringing women's activities and experience into the public sphere, feminist standpoint theorists aim to contribute to a transformation in consciousness (Seyla BENHABIB, 1995, p.164).

The reader might have noticed that the singular has been used when referring to the women's experience and the privileged standpoint, among others examples. This suggests that there is one universal shared experience and shared standpoint common to all women. While this was the consensus in early works within this current, this drew a critical response from marginalized women. Racialized and lesbian subjects branded this essentialism as ethnocentric, analitically reductive, and politically ineffective. As a result, some feminist standpoint theorists moved away from the universalization of women's experiences (Sandra HARDING, 1991). While not a member of this collective, Donna Haraway's situated knowledges has also proved to be a fruitful source of inspiration in this respect (Carme ADAN, 2006, p.133).

3.2. Situated knowledges

"Though both are bound in the spiral dance, I would rather be a cyborg than a goddess", said Donna Haraway (1991, p. 181). This expression condenses an important part of her thought: the symbol of the goddess serves, on the one hand, to problematize the standardization of women's experiences; on the other, it is also useful for calling into question the romantization of subaltern positions (Barbara BIGLIA, 2005, p. 59).

With respect to the homogenization of women's experiences, Haraway (1991) considers this to be a mistake as doing so reproduces, and thus reinforces, the strategy of dominant patriarchal

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discourses to homogenize dissenting marginalized viewpoints. She denies the existence of a monolithic identity encompassing all female bodies, which are in fact traversed not only by gender but also sexuality, race and class among other factors. She calls an emphasis on the diversity of voices, as well as for taking account analytical categories in addition to gender (ADAN, 2006, p. 163).

With respect to the romantization of subaltern positions, she states the following:

> Subjugated standpoints are preferred because they seem to promise more adequate, sustained, objective, transforming accounts of the world. But how to see from below is a problem requiring at least as much skill with bodies and language, with the mediations of vision, as the highest techno-scientific visualizations. (HARAWAY, 1991, p. 191)

Inasmuch as there is no immediate vision, even from the standpoints of the subjugated, the doing of science requires instruments of vision that will mediate such standpoints. In other words, developing an optics translates to positionings; and, unlike social positions, critical positionings do produce science (HARAWAY, 1991, p. 193).

Subaltern or not, scientists always produce science from a certain standpoint. Insofar as this standpoint is never neutral, knowledge is always partial. Therefore, when producing science, it is essential that the knowers mark their subject positions. Such explicit statement of partiality is what Haraway identifies as situating knowledge (p. 191).

Haraway understands (feminist) objectivity to be a conversation between situated (i.e. partial, unfinished) knowledges (ADAN, 2006, p. 172). Such a notion of objectivity does not restrict interactions to subjects of knowledge (i.e. scientists); on the contrary, she states that the scientific community as a whole (including objects of knowledge) should take an active part in the dialogue (p. 207). In that way, objects of knowledge are recognized as agents; in turn, empathy is favored over confrontation, which leads to questioning the pairing subject/object (p. 177).

Acknowledging the partiality of knowledge does not imply a relativistic "anything goes". On the contrary, positioning implies responsibility for one's practices (HARAWAY, 1991, p. 193), as well as objectivity by producing "partial, locatable, critical knowledges" that sustain the possibility of shared conversations within the scientific community (p. 191). Accordingly, for Haraway, the subject of feminism is the *cyborg*, which she defines as a "subjectivity synthesized from fusions of outsider identities" (p. 174) that performs from different positionings, but not from any positioning.

All six subjects who I chose as interlocutors for this study describe themselves as female feminist scientists. Such adjectives describe their ascribed social positions, but also their conscious positioning(s) and opposition(s), inasmuch as they claim to be women who explicitly perform science from feminist standpoints. They are thus, following Haraway (1991), cyborgs.

4. Research design

4.1. Technique

Methods and techniques should be in accordance with a study's theoretical approach. In-depth interviews meet this criteria and facilitate a closer view of the experiences, discourses and practices of the interviewees, as well as giving them space to share their understandings, emotions and actions (Zina O'LEARY, 2004, p. 165). Theory was applied to the analysis of interviews through the isolation of several key discourses, around which the following analysis is structured. In order to avoid analytical reductionism, attention is drawn not only to convergences, but also to ideas present in the interviews which resist easy categorization.

4.2. Sample

The present work aims to understand how gender systems shape and are shaped by science systems. To this end female scientists are taken as guides because, even if "subjugation is not grounds for an ontology" (HARAWAY, 1991, p. 193), it can provide insights for a more complex perspective (HARDING, 1991).

Furthermore, when doing science, positionings are (at least) as important as positions. In fact, Haraway (1991) argues that subaltern positions might provide "visual clues", but developing a vision demands optical instruments, i.e., a politics of positioning (p. 193). Therefore, interview subjects who identified themselves as feminists were recruited. The decision derived from the following hypothesis: a shared understanding of oppressions caused by gender systems, as well as instruments of vision to identify these oppressions, is more likely to be held in common amongst self-identified feminist subjects.

As mentioned in the introduction, as this paper is part of a wider study focused on mathematics education, interviewees qualified as mathematicians or holding degrees in areas with a large mathematical component were selected. Attention was paid to age diversity in order to include voices from different points in scientific careers. Additionally, a diversity of feminist

perspectives was also prioritized and established by looking over candidates' public statements on the topic.

In brief, subjects were selected in accordance with the following criteria:

- Being a mathematician, or participating in a scientific discipline with a large mathematical component.
- Being a woman.
- Being a feminist.
- Age diversity.
- Diversity as regards their feminist standpoints.

Finally, six female feminist scientists living in the Basque Country and linked to UPV/EHU were invited to take part in the study in December 2018, with all those approached agreeing to participate.

The interviewees' pseudonyms are Haizea, Ester, Irene, Karmen, Rosa and Clara. Haizea is a 31-year-old physicist. Ester, Irene and Karmen are mathematicians, and they are 40, 57 and 64 years old, respectively. Rosa is a materials engineer, and she is 53. All five interviewees work at UPV/EHU as researchers and teachers. Clara is a mathematician; she is 35 years old, and she is co-creator of an association that both reflects and acts on the potentialities of feminism as a tool for scientific education.

Interviews were conducted in the same order as shown in the table, between November 5th and December 4th 2018, in locations chosen by the participants. These sessions, which were recorded and transcribed for further analysis, varied in length: the shortest one lasted 35 minutes, the longest about two hours, and the remaining four from 60 to 90 minutes.

5. Results

Scientific disciplines proclaim themselves capable of knowing Truths that are neutral and provable, which is what makes them distinct from others (Ellen MESSER-DAVIDOW, 1991). Students of science are socialized into this culture, as well as imbued with its perspectives and values. Thus, learning a certain scientific discipline "is not merely a matter of acquiring knowledge" (Nancy BRICKHOUSE, 2001, p. 286), but also "a process of coming to be, of forging identities in activity in the world" (Jean LAVE, 1992, p. 3).

Accordingly, so as to come to be part of a (scientific) discipline, one's identity is attuned to it. However, reciprocity between identity and science is not fortuitous since, as argued above, the image of the archetypal scientist is strongly correlated with the image of the white middle-class male.

Interviewees remember their initial contacts with science as being harmonic. However, unsurprisingly, they also acknowledge that, as their scientific careers progressed, such harmony diminished and tensions and conflicts arose.

On the one hand, they report hierarchical, aggressive and competitive behaviors among some scientists, especially those who held positions of power, as well as stating that the scientific community would accept and, in some cases, even promote such behaviors. On the other, they claim womanhood and feminism (i.e. both the position and the positioning) to have been sources of tensions in science systems ruled by such behaviors. Beyond denouncing these values, this paper delves into complex relationships between behavior and identity and how conflicts at this level have affected their habitation of science systems.

5.1. Identities in conflict: bodies as battlefields

Conflicts tackled in the pages that follow are influenced by external factors, but are also, to some extent, endogenous. Identities in conflict are interrogated in the paragraphs below.

5.1.1. Woman VS Scientist

Ester identifies gendered dynamics when she recalls the congresses she attended while she was a doctoral student.

> Ester: When presenting our projects, young men and women would take up space in very different ways: we girls would stay behind the desk or next to the computer; meanwhile, the guys stood in the middle, taking up much more space than us. Also, when addressing questions or concerns, we girls would adopt this undecided tone, while guys' tone was much more assertive... All that makes a big difference[3].

Haizea remembers that during her doctoral studies, students had to present results in front of their research groups on a weekly basis. She mentions that when doing so women, herself included, would put themselves under additional pressure as compared with men, as well as feel

[3] Four of the interviews were conducted in Basque, a language which was illegal until 1975. The remaining four were conducted in Spanish. Translations by the author.

much more insecure. She believes this discomfort to be linked with the scientific authority as a way of performing masculinity:

> *Haizea: Some writings link the unease sensed by some female scientists with how authority works in science. They argue that, when defending our work, it is often hard for us women to perform authority. According to them, that is because we always end up needing the approval of the authority that is intrinsic to science, which is masculine.*

Haizea's reflection about the implications that scientific authority's masculine character has for female scientists is consistent with some writings regarding academic-scientific hierarchies:

> In society the characteristics of leadership and competence are defined as masculine traits, meaning that women who do not model their leadership behavior after traditional male role models may not have their effectiveness recognized or be perceived as successful. (Oliver COOPER, 2019, p. 94)

Women who do not perform masculine models of leadership may therefore experience more difficulty ascending academic hierarchies. It is worth noting that hierarchies within the UPV/EHU and the institutional apparatus for creating, recognizing and maintaining them do not correspond directly to those experienced by Cooper. For example, the role of Vice-Dean, held by two interviewees, is officially an elected role that rotates among senior staff and does not confer the power to hire and fire. While general dynamics of gender and power appear to be generally applicable, concepts such as "hierarchy" operate differently in specific contexts.

5.1.2. Young VS Scientist

The two youngest participants of the study, Clara and Haizea, describe the pairing youth and science as conflictive: for them, just as youth is linked with abundance in social life, pursuing a scientific career means spending hours and hours surrounded by nothing but books on a daily basis:

> *Clara: I studied non stop during the whole degree, both during the week and on weekends. My friends from the neighborhood would go out every weekend, and I remember having to say rather frequently, "I can't go out, I need to study for this exam", or "I have to finish this project", or whatever… I felt very insecure about my math skills.*

Clara narrates that studying for a mathematics degree left less time than desired for friends. Haizea, on the other hand, has the feeling of having missed experiences which she regards as crucial to one's personal development. There is a link in both narratives between unmet social needs and lack of confidence in their scientific skills. Haizea believes this lack of security to be related to the *impostor syndrome*:

> Haizea: The impostor syndrome is when someone gets a so-called successful job and keeps thinking that they don't deserve it, that there are other people who would be much better at it, and that they are incapable of doing the job. All that makes them feel like impostors, as well as frightened that their incompetence might be discovered. (…) I had these kinds of thoughts during all my doctoral studies.

Impostor syndrome is a behaviour that was first brought to public attention by feminist psycotherapists Pauline Clance and Suzanne Imes (1978), who defined it as follows:

> [Impostor syndrome is] an internal experience of intellectual phoniness which appears to be particularly prevalent and intense among (…) high achieving women. Certain early family dynamics and later introjection of societal sex-role stereotyping appear to contribute significantly to the development of the impostor phenomenon. Despite outstanding academic and professional accomplishments, women who experience the impostor phenomenon persist in believing that they are really not bright and have fooled anyone who thinks otherwise. (Pauline CLANCE; Suzanne IMES, 1978, p. 241)

In both Clara's and Haizea's cases, impostor syndrome imposed a dramatic increase in working hours and, therefore, at the cost of time spent meeting social needs. In conclusion, inasmuch as lack of security in one's scientific skills is gendered, so is the deterioration of one's social life.

5.1.3. Activist VS Scientist

A tension between political commitment and scientific endeavor is also identified in some of the discourses analyzed. Clara, for instance, doubted that her degree in mathematics would contribute to building a more just world. During her studies, her main concerns were, along with the level of abstraction, her future job prospects:

> Clara: Most of my mathematician friends who didn't become mathematics teachers ended up working as market data analysts. I actually got offered this type of work once I finished my

> degree. I reasoned that, in a job like this, I would be helping businesses earn more money by promoting consumerism, which contradicted my values... So I decided to turn down the offers.

Rosa, on the other hand, remembers having had concerns regarding the applications of the knowledge produced during her doctoral studies:

> *Rosa: I was volunteering at a NGO at the time, and I agreed to go to Chiapas with Guatemalan refugees as an international observer shortly before completing my doctoral studies. "What do you do for a living?", female refugees asked us observers rather frequently. My PhD was about solid-state synthesis of a ceramic material, and I didn't know how to explain that to them; but, more importantly, I myself didn't know about the applications that my findings might have. That's how my concerns regarding materials engineering as a discipline began to arise.*

With respect to the conflict some interviewees experienced in relation to their activist commitments, Linda Sax, Kathleen Lehman, Ramón Barthelemy and Gloria Lim (2016) note that women in science are less likely than women in other academic fields to have a social activist orientation. This suggests a possible structural tension between their identities as scientists and feminists. Interviewee's narratives identify the presence of systems of gender within science systems, and once again demonstrate that performing science is a problematic activity for women. Their narratives describe a type of archetype of the subject that does science. This subject can, desires and knows how to perform aggressiveness, competitiveness, authority and neutrality. It is, unquestionably, a historically masculine subject.

I understand the conflicts described above to have been *milestones* in these scientists' professional lives, given that they did in fact lead to the calling into question of their practice of science, as well as to transformations in these practices. Such cathartic moments are addressed in the following section.

5.2. Milestones: embodying new perspectives on science

Feminist anthropologist Teresa del Valle defines milestones as important moments in life that leave a mark on one's future (Quesé BLANCO; Sara EGIDO; Axel AUBINYA, 2010). Three of four such transformative moments are described below.

5.2.1. Rosa

Around the time Rosa was volunteering in Chiapas, a fellow PhD student realized that his object of study was being tested for military applications. This gave Rosa a growing cause for concern regarding the possible applications of her own object of study:

> *Rosa: Materials research has multiple contexts; the department where the research is carried out is, of course, one of them; but the businesses that are interested in a certain material and thus finance their development are also central, as well as the implications that such interests might have in our globalized societies. When I was researching this ceramic material, I was aware that my research was being financed by certain businesses, but I couldn't see any further.*

Rosa finally expressed these concerns to her supervisor. His answer was that their job as scientists had nothing to do with applications, but with research; and that such political decisions were not any of their business. "Whatever, but not in my name", was her response. Once she finished her PhD, she quit materials research right then and there.

5.2.2. Haizea

Having spent most of the five years of her physics degree surrounded by nothing but books, Haizea decided that it was time for her to enrich her social life. One of the many doors she opened led to an engagement with feminism, which turned out to be helpful in both her personal and professional life:

> *Haizea: I realized that, in spite of science claiming to be source of truth, objectivity and justice, science systems are in fact shaped by competitiveness and economic interests. I was finishing my PhD at the time; and feminism gave me not only the tools to identify such hidden aspects of science, but also the strength to say, "I don't want this".*

Haizea decided to redirect her scientific career. She gave up her line of research and started searching for paths and projects that would help construct a more feminist science.

5.2.3. Clara

Clara's biggest concern during her mathematics degree was the lack of connection between her studies and social issues. Her job prospects also worried her as none inspired her interest. When an older classmate enrolled in a MA in International Development, Clara realize that she could do likewise.

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> *Clara: I came to Bilbao and studied a MA in Development and International Cooperation, which opened my mind to the idea of critical education in science. It was then that I saw clearly that my professional path would combine these two elements [science and critical education] that move me and that I really like.*

New perspectives from which to see and do science, in which ethics and politics explicitly play a key role, emerged from the milestone moments described above. Such perspectives are described in the section below.

5.3. Loopholes: alternatives for inhabiting science

The women interviewed admit having found themselves at crossroads when trying to articulate scientific and feminist practices. But, paraphrasing Foucault (1980), wherever there are crossroads, there are also *loopholes*, which Teresa del Valle defines as foresight moments in which one manages to envision a way out from a crossroads (BLANCO; EGIDO; AUBINYA, 2010). Thus, inasmuch as the pursuit of articulating feminist and scientific practices entails the inhabiting of crossroads, it also leads to the production of loopholes.

5.3.1. Counterspaces

Counterspaces are one of the main types of loopholes identified in interviewees' discourses. Ong, Smith and Ko (2017) describe them as follows:

> [Counterspaces are] academic and social safe spaces that allow underrepresented students to: promote their own learning wherein their experiences are validated and viewed as critical knowledge; vent frustrations by sharing stories of isolation, microaggressions, and/or overt discrimination; and challenge deficit notions of people of color (and other marginalized groups) and establish and maintain a positive collegiate racial climate for themselves. (…) [They are ought to] help to facilitate students' social integration by providing a sense of cultural connection, a space to develop and express their racial/ethnic or gender identities as well as to give back to their communities by supporting other students like themselves. (Maria ONG; Janet SMITH; Lily KO, 2017, p. 209)

As regards counterspaces, Rosa mentions the creation of a focus group:

> *Rosa: A bunch of scientists who worked in the University of the Basque Country created a focus group with the aim of enriching our knowledge on gender and science. We initiated this self-training process by reading and discussing Mileva Maric's (Einstein's first wife's) biography.*

Clara, together with Lulu, a masters classmate, used to fantasize about creating a space in which to reflect on and share alternative perspectives on science. They finally turned this fantasy into reality by creating an association[4]:

> *Clara: Lulu and I gathered some people who we thought might like to join the project, and started thinking about issues that concerned us, as well as in ways to address them. I said I'd like to look into the convergence of feminism, science and education, and Lulu mentioned her interest in food sovereignty… That's how it started.*

Through her political activism, Karmen began to engage with feminism. This in turn led her to identify and call into question gendered dynamics in both activism and science:

> *Karmen: Shortly after Franco [former Spanish dictator] died, just when I started working at the university, a women's provincial assembly was created in Bizkaia. I decided to go to the meetings and, as some of us were scientists, we ended up doing a presentation on women and science in one of the encounters. We were concerned about our job as teachers, as well as about the fact that we barely knew anything about women who had made history in science... That's how we started reflecting on gender and science.*

Ong, Smith and Ko (2017) write that even though "the word 'counterspaces' indicates settings and practices in the margins of the mainstream, (…) opportunities at the center can and do exist that promote, and are more inclusive of, underrepresented students" (ONG; SMITH; KO, 2017, p. 210). Ester describes one such institutional counterspace:

> *Ester: I took part in this women's leadership program which I found to be really interesting. We were taught how to deal with work group conflicts through group dynamics. We also reflected upon limiting factors, both self and externally imposed, that inhibit women from advancing into leadership positions.*

The program is called *Akademe: A women's leadership program for academics in the University of the Basque Country*. It aims to provide formation to women academics that will be

[4] As stated on their website, the association's main objective is to work towards a society and a science based on equality and sustainability. Their activity is based on a set of premises: firstly, they consider science neither neutral nor objective; secondly, they understand care for people and the environment to be a key value; lastly, they see it as essential to acknowledge and value knowledges and knowers historically undervalued and/or rendered invisible.

helpful when advancing into leadership positions. According to the document advertising the program, the aim is "to create a mutual aid network between women academics that will allow them to share their concerns, experiences, successes and difficulties, as well as facilitating both access to and continuity in management-level jobs" (BERDINTASUNERAKO ZUZENDARITZA [University of the Basque Country Gender Equality Unit], 2019).

Despite these counterspaces sharing common features, for example a commitment to gender parity in science, they differ in their content, methods and objectives. In the counterspaces described by Rosa and Clara, science itself is called into question. Moreover, the wish to develop more critical and less restrictive instruments of vision with which to look at knowledge and science is strongly perceptible in their descriptions. Karmen, on the other hand, reports a need to recognize contributions made by female scientists. Lastly, the women's leadership program described by Ester aims to mitigate the strong gender imbalances existing in academic hierarchies[5]. However, it might be argued that by limiting its ambitions to achieving numeric parity of men's and women's participation at different hierarchical levels, this program does not necessarily seek to achieve significant changes in the hierarchical practices of the institutions themselves. Spaces created for underrepresented groups may share the ambition to promote learning and sharing experiences, but they are also diverse to the point where contradictions emerge between them in terms of both aims and practices.

5.3.2. Megaphones

The interviewees tend to use their public voices with a view to instill feminist values in science systems. Irene, who recently received a reward for her work on behalf of gender equality, believes that her voice has gained both volume and legitimacy due to this recognition and is determined to make the most of it:

> *Irene: The award has strengthened my public feminist discourse. For example, I've been stating lately that the problem of us women in science is the absolute lack of respect for women both in science and elsewhere, which creates a great amount of discomfort among listeners. That's because I usually speak in science communication forums, which tend to be non-feminist. I am aware of the fact that such statements make enemies, but I do it anyway; now I feel strong enough to do it.*

Clara's association publishes articles on a bimonthly basis in a feminist magazine. The writings report the work of women scientists, as well as linking science with knowledge related to care work historically carried out by women not normally recognized in academic forms.

> *Clara: I really enjoy the creative process that the articles imply. It's like giving yourself time to delve into the life of a woman scientist as well as into the knowledge she developed. Also, acknowledging and making visible scientific contributions of all these women (whether scientists or not) is, to me, a matter of social justice.*

Haizea seeks to stimulate public discussion on the nature of science. With this in mind, she collaborates with local media:

> *Haizea: Sara[6] and I are in charge of the science section in a live news show on a left wing local radio station. We try to do science communication from a feminist perspective, and I think that's great, because heaps of people in the city listen to the show, which opens up the possibility of bringing science into the agenda of social movements.*

While interviewees' perspective regarding science and gender clearly affects the way they communicate science, in some cases it also affects the way they do science. This topic is addressed below.

5.3.3. Feminist science

What some of the interviewees understand as feminist science is linked with their conception of feminism itself. Haizea, for instance, defines feminism as follows:

> *Haizea: To me, feminism is a form of struggle, a way to fight capitalism and to shift power relations. It makes you call into question the whole society, from top to bottom. (…) As feminist scientists, we should ask ourselves about what lives are worth living, and work to build a scientific system that is consistent with such lives, not the other way around.*

Nowadays, she seeks out lines of research that are consistent with these values. She is in touch with a research group that has done some relevant work in topics related to energetic transition.

[5] *Senior professor* and *emeritus professor* are the top ranks in the academic hierarchy, and 25,53% and 9,09% of such positions are held by women, respectively, in the University of the Basque Country. By contrast, one of the lowest academic ranks is *assistant professor*, in which the percentage of women increases to 76,47%.
[6] Sara is a pseudonym.

Rosa, on the other hand, describes feminism in inclusive terms. She believes diversity to be the key word. Accordingly, she conceives of her scientific practice in these terms:

> *Rosa: My present research interests are related to interpretation of spaces. In our research group, we keep asking ourselves questions such as "how can we make the spaces that surround us more liveable?" When reflecting about these issues, gender is a category to be taken into account. It is not the only one, but it is a crucial one, because it traverses all the remaining categories that make us as diverse as we are.*

Both Haizea and Rosa locate themselves discursively within feminist epistemological positions when they talk about putting life at the centre, and the need to situate knowledge. Clara's discourse evokes feminist standpoint theory when she talks about making women's experiences visible and of recognizing the value of the knowledge inherent in practices historically carried out by women. Karmen also mentions, on a number of occasions, the non-neutrality of science over the length of the interview. This said, Irene and Ester did not appear to question scientific values including objectivity, neutrality or universality. The absence of the question of epistemology in their narratives could be ascribed, at least in part, to their research area. Both have worked in abstract mathematics, analyzing mathematical objects, and work in this area does not demand that possible practical applications be considered by researchers. Reading mathematical knowledge as universal truth exempt from concerns related to situatedness applied to other fields is not a new or minority position. Michel Foucault exempted mathematics from his criticism of science in the seminal *The Archaeology of Knowledge* (Suzanne DAMARIN, 2008).

The question of epistemology outlined above leads to another key question at the intersection of feminism and science. Elizabeth Fee (1981) states that as long as societies remain sexist, feminist scientists cannot provide more than a feminist critique of science. However, Haizea and Rosa seem to identify their practices of science as coherent with their feminist identities and beliefs. This suggests that feminist science, which not only confronts but also changes the regulating norms of the science systems, is already taking place.

6. Some conclusions

This paper was inspired by a question raised by Evelyn Fox Keller more than three decades ago: how might a feminist conception of society modify our conception of knowledge? While this paper does not provide a complete or definitive answer, it has addressed repressive and productive dimensions of gender dynamics in scientific-academic spaces through interviews that explored the scientific optics and practices of feminist female scientists.

This study does indicate that scientists with a feminist perspective have developed instruments of vision that allow them to identify and resist oppressions caused by gender systems. This was a common thread across all the interviews. Also present, however, was a diversity of experiences, optics and actions which resists a reductionist reading.

All interviewees consider both femaleness and feminism to be a source of tension in science systems. They also report identitary conflicts arising from these tensions, as well as describing how these conflicts influence ways in which they inhabit science systems. This said, there was significant diversity in terms of the impact of these conflicts and individual responses. Four of the interviewees acknowledged having called into question their own scientific practices at certain points. Such moments were experienced as milestones, as they became points of reference for their future perspectives and actions in science. The remaining two interviewees' discourses, on the other hand, showed no radical discontinuity between past and present ways of seeing science.

As regards their perspectives on science, four of the interviewees called into question the positivist values historically attributed to science: objectivity, neutrality and universality. They drew attention to the impact of other institutions, such as the military, have on science. Beyond this being a political critique, they also resisted the imposition of Cartesian dichotomies such as rational/non-rational, mind/body and public/private, and the way these have led to rigid and exclusive definitions of science. The remaining two, on the other hand, made no statements that would call into question these enlightenment values.

Two widely shared practices were identified. One was the creation of counterspaces, although these spaces varied significantly in their contents, methods and objectives to the point where the values defining these different spaces became contradictory. Another was science communication, but approaches also differed in terms of target public, means, content and purpose. The overall goal was shared: to use communication to achieve more inclusive science.

Lastly, it can be concluded that experiences, positionings and actions in science systems are influenced by the specific scientific discipline that one inhabits. In this sense, results suggest that the level of abstraction of a certain discipline might condition the epistemic positioning of a scientist. Be that as it may, despite the divergences, results also confirm that scientific disciplines do share common values, rules and inertia.

On this basis, the study aimed to give an account of six female feminists' commitment to, paraphrasing Haraway (1991), seizing "the tools to mark the world that marked them as other" (p. 175). Without identifying universals, it has documented inclusive and transformative ways of thinking about, acting upon, and inhabiting science systems.

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Uzuri Albizu Mallea (uzuri.albizu@ehu.eus) is a lecturer in the Faculty of Education at the University of the Basque Country. She holds a BA in Mathematics and MAs in Mathematics Education, Secondary School Teaching, and Feminist and Gender Studies. She is curretly a PhD candidate at the University of the Basque Country in Feminist and Gender Studies. Her PhD delves into the ways in which mathematics identity and gender identity intersect.

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