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At Hesitant Doors: The lived experience of women in STEM

Romina B. da Costa

University of Maryland, College Park

ABSTRACT

This phenomenological investigation aims to explore the lived experience of women in Science, Technology, Engineering and Mathematics (STEM) disciplines. As a minority group within a traditionally male-dominated space, women are still underrepresented in the upper echelons of science, even if the number of women in STEM is increasing. The author draws from her experiences as an "undesirable statistic," a woman who entered college as a STEM student but ended up getting a degree in the social sciences. The author attempts to gain some new insights and understanding of the issue of women in STEM, engaging in two in-depth phenomenological conversations with a female engineering student in a large public university of US Mid-Atlantic region.

Keyword: *Gender - Gendered Spaces - Science Education – STEM – Women*

Alla porta esitanti: l'esperienza vissuta dalle donne nelle STEM

Questa indagine fenomenologica si propone di esplorare l'esperienza vissuta dalle donne nelle discipline STEM (scienza, tecnologia, ingegneria e matematica). Le donne - gruppo di minoranza all'interno di uno spazio tradizionalmente maschile - sono ancora sottorappresentate nelle alte sfere della scienza, sebbene siano presenti nelle STEM in numero sempre crescente. L'autrice attinge dalle proprie esperienze come una "indesiderabile statistica", che si è iscritta all'università in una facoltà STEM, ma ha finito per ottenere una laurea in scienze sociali. L'autrice tenta di raggiungere alcune nuove intuizioni e di comprendere la problematica delle donne all'interno delle discipline STEM, attraverso due colloqui fenomenologici in profondità con una studentessa di ingegneria in una grande università pubblica nella regione Centro-Atlantica degli Stati Uniti.

Parole chiave: *Genere – Ambienti di genere – Educazione Scientifica – STEM – Donne*

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Phenomenological Turning

An Undesirable Statistic

> *"Master K warns me not to expect more than half a dozen students for the tea…to discuss "gender inequalities in science." Oh, don't worry, I say, thinking that if five or six young women show up, I'll be delighted.*
>
> *And so, when eighty young women (and three curious men) crowd into the dining room…Master K and I are stunned."* (Pollack, 2015, p. 166)

I am an undesirable statistic. So are Pollack, and a host of other women I have met who started off their academic journeys in STEM. In the eyes of higher education specialists, administrators and policy-makers, we are examples of STEM attrition: students who chose to leave the STEM disciplines. We are women who dropped out of STEM at a time when many highly qualified and important people are trying to figure how to keep more women and other underrepresented groups in STEM.

I graduated from university in 2007. Eileen Pollack's visit to her alma mater for the Master's Tea described above happened in 2010. This is the 21st Century. My classmates and I, female or otherwise, have always been told we are the best and brightest, that the possibilities before us are unlimited. In spite of all this I felt myself hesitantly at first, and then more decisively, turning away from STEM.

It wasn't until many years later that I reflected on the gendered nature of my experience. At the time, I did not feel like I was experiencing a climate that was hostile to female students; when I first heard the statistics about the problem of STEM attrition and the dearth of women in STEM, I was in disbelief – it didn't seem to reflect my experiences. I knew of plenty of women in my science classes; I could not recall an instance of overt discrimination; and while I ended up majoring in a social science, I know of many talented women who majored in STEM. However, when I considered how many of those women continued in STEM beyond their undergraduate years, the problem made more sense to me. While many of my core undergraduate STEM classes had gender ratios that were close to fifty-fifty, my female friends who remained in STEM described that in the higher-level courses, especially in math, physics and engineering, they were often the only women in their classes. Of the five talented women I know who did graduate in STEM fields, three are lawyers now and the other two are pediatricians. So while women are entering STEM in numbers that approximate those of men at the beginning of their undergraduate studies, they are dropping out at every level.

What could be causing women like me to leave STEM? Why is it something that so often goes unnoticed by those women themselves as they experience it? It is very telling that in the quote above, Eileen Pollack and Master K did not expect more than a handful of students to show up for the discussion of gender inequalities in science. The prevailing discourse on college campuses is that we live in a post-feminist era, and that gender inequality is a thing of the past. It is even more telling that such a large number of undergraduate women made it to the Master's house to attend this meeting, despite the short notice and the lack of publicity for the event. How many women in STEM feel like they have a story to share and no one to share it with, or nowhere to share it?

Existential Investigation

We tend not to think about our masculinity or femininity on a daily basis. For the majority of us, our gender normativity means that our gender and the ways in which we live it, embody it and project it, are things that we usually take for granted. Remembering childhood experiences of being taught the proper way to sit, to walk and even to eat like a girl, it is easy to revisit the ways in which I have grown into my femininity as my body has been taught to carry itself and move in certain ways. Less obvious, however, are the ways in which I have been taught to see, feel and think like a woman, and to respond to my environment like a woman. In light of this, understanding STEM spaces and environments and the gendered ways in which people respond to those spaces is central to this inquiry.

Neither Outside nor Inside: Standing at the threshold of science

> *La porte me flaire, elle hésite.*
>
> (The door scents me, it hesitates) – Jean Pellerin, as quoted in Gaston Bachelard's, *The Poetics of Space: The classic look at how we experience intimate places*

In *The Poetics of Space,* Gaston Bachelard (1994) elaborated on the idea of being outside versus inside a space. He devoted part of his chapter to doors and doorways, these thresholds between the outside and the inside, these spaces of transition, and the possibilities that they represent. Historically, STEM spaces have been constructed and occupied by men. In contrast, women have been kept on the outside or, at the very least, at the margins of the scientific endeavor until relatively recently. How do women enter STEM spaces, and what is

it that they experience when they do? Are the doors guarding these spaces wide open to women, as some would have us believe? They are definitely no longer "closed, bolted, padlocked;" but as Bachelard points out, there are many possibilities in between these polar opposites – might they be "just barely ajar?" (pp. 222). When it comes to the STEM spaces, is it not true that the majority of gatekeepers are still men? What does this mean for the women who are seeking entry, and how might it shape their understanding of what being in that space entails?

Science, the Body, and the "Bodies" of Science

> The body is not a thing, it is a situation: it is our grasp on the world and our sketch of our project.
> (de Beauvoir, 1972, p. 38)

We often talk about "bodies of knowledge" when referring to the products of certain disciplines. It is as though knowledge itself is taking on a human form. Yet within the scientific discourse, the "truth" exists "out there", completely separate from the observer; we do not have to create order, we simply have to perceive and understand it; the term discovery itself implies the un-covering of things that are sitting there waiting to be observed, and dis-covery is a big part of what science is said to be about.

However, if God himself had to make use of a model (his own image) to create Man, is it not too presumptuous of us to think that the bodies of scientific knowledge that we create are not reflections of ourselves? Can we really separate ourselves from our creation? Even if we accept that it was all sitting there, waiting to be dis-covered, we are still responsible for naming what we see, making sense of it, and building up the so-called bodies. What forms do these bodies take? Who defines the shape of their limbs, the curve of their backbone, the width of their hips? Is it not true that "even anatomy (a supposed scientific undertaking) is interpretation" (Steeves, 2006, p. 114)? And if a body of knowledge is dominated by a certain kind of knower, or maker, won't that body begin to look more and more like one type of person, to the exclusion of others?

Simone de Beauvoir may have put it best when she wrote, "the body is not a thing, it is a situation: it is our grasp on the world and our sketch of our project" (de Beauvoir, 1972, p. 38). While de Beauvoir was referring to the human body generally, and to the female body specifically, her analysis can be extended to our understanding of "bodies of knowledge" and "scientific bodies" as well. Even these objective ways of knowing through dis-covery are

inextricably tied up with accepted ways of understanding the world, and with the political and social structures that dictate who performs the uncovering.

The Construction of Womanhood and Science

> *"That man over there says that women need to be helped into carriages, and lifted over ditches, and to have the best place everywhere. Nobody ever helps me into carriages, or over mud-puddles, or gives me any best place! And ain't I a woman? Look at me! Look at my arm!…I could work as much and eat as much as a man…and bear the lash as well! And ain't I a woman?..."* (Sojourner Truth, delivered 1851 at the Women's Convention in Akron, Ohio)

The idea that "one is not born, but rather becomes, a woman" (de Beauvoir, 1972, p. 301) has been repeated to the point of becoming cliché. However, it is the extension of these ideas to the bodies of science that is of interest here. Could we say, "science is not born, but rather becomes, a science?" If so, was science not born of a man's body, and constructed in man's image?

This is not to be dismissive of the long history of women in science, and the multitudes of women who have made enormous contributions. It is, however, to point out the ways in which even the most important female figures in science were shunned and excluded from the upper echelons of the academy. Marie Curie was denied membership to the French Academy of Sciences in 1911, despite being the first person to ever receive two Nobel Prizes; even as the number of women in the science-training pipeline has grown, women are still disproportionately excluded from higher paying tenured and tenure track positions, and in leadership positions in academia (Crasnow et al., 2015). The consistent exclusion of women from the highest levels of knowledge production in the STEM fields may continue to allow these bodies of knowledge to be defined in ways that favor more traditionally masculine ways of knowing and being.

Today, more than ever before, female scientists are carving out spaces for themselves, challenging "notions of the naturally sexed body" in a way that Steeves likens to female bodybuilding (Steeves, 2006, p. 119). "Ain't I a woman?" these female scientists might ask. Yet female scientists are expected to exist as women within bodies (of knowledge) that are male. Female scientists are, in a sense, women in male bodies. Women enter science "awkwardly and uninvited," bringing with them ways of thinking and being that are decidedly un-masculine (Steeves, 2006). Women in STEM thus face the double burden of defying gender stereotypes while working to feminize a body of knowledge that was built to

fit a masculine mold. Perhaps this burden, and the way that women in science experience it, can shed some light on the phenomenon of STEM attrition.

Returning to Bachelard's idea of thresholds, we can presume that the doors of science, upon scenting a feminine scent, do not swing open but rather, hesitate. In being allowed in, women are expected to abide by the rules and patterns established by the men who came before them, to leave behind their "touchy-feelyness," and to get on with the business of discovery as their male predecessors have done.

A War of Attrition

When an excerpt from her book *The Only Woman in the Room: Why science is still a boys' club* appeared in the New York Times Magazine in 2013, author Eileen Pollack received dozens of letters from women who connected with her experiences as a Physics student at Yale, and who had felt similarly "worn down by the continual need to fight for respect, not only from male professors and colleagues but also female colleagues, students and staff" (Pollack, 2015, p. 236). The "wearing down" that connected Pollack's experiences to those of so many other women in the sciences, across generations, suggests that the phenomenon is real, that it happens in a variety of institution types, and that the answer to the so-called issue of STEM attrition may indeed lie in the ways in which the sciences are constructed and maintained as male spaces.

Examining the etymology of the word "attrition" is revealing of the ways in which the STEM fields may be acting to wear away at the women present in those spaces. From the Latin *attritionem*, literally "a rubbing against," the noun attrition originated from the verb *attere* "to wear, rub away," or "to destroy, waste," hinting at the gradual reduction and eating away of women in scientific pursuits at all levels (Online Etymology Dictionary). Tellingly, the word takes on more bellicose connotations in contemporary English usage, with the New Oxford Dictionary of American English defining it as "the action or process of gradually reducing the strength or effectiveness of someone or something through *sustained attack or pressure*" [emphasis added].

It is possible that an invisible and silent war on women is taking place within scientific spaces at this very moment. Crucially, however, we are failing to hear the stories of the women themselves and as such, may be missing an important part of the picture.

The Female (Body) in the Masculine (STEM Space)

> […] Body and place belong together from the very beginning. Their fate is linked – not only at the start but at subsequent stages as well. (Casey, 1993, p. 45)
>
> The power a place…possesses determines not only **where** I am…but **how** I am together with others…and even **who** we shall become together (Casey, 1993, p. 23)

The STEM spaces are inseparable from the bodies that inhabit those spaces, and from the bodies of knowledge produced within those walls. In the words of Casey (1993), their "fate is linked" through time, implying that once things are set into motion, there is continuity in their relationality. As female bodies have moved into these STEM spaces – the lecture halls, the laboratories, the faculty meeting rooms and student dormitories – they have come to occupy spaces that were built by men to accommodate male bodies. This can be said both of the physical spaces but also more broadly, of the intellectual and rhetorical spaces that make up the STEM enterprise.

There are many ways in which women experience physical spaces differently from men. For example, a recent UVa study documented how women (but not men) felt that the campus was too dark at night, undermining female students' willingness and desire to stay late at campus libraries and lab facilities (UVa CHARGE, 2015). In this particular case, the way in which women perceived campus as physically threatening could undermine their ability to remain in lab facilities late at night, which is often required in order to excel in STEM fields. While students in the humanities and social sciences might be able to complete a lot of their work from the safety of their home or dorm room, students in SEM often engage in work that requires them to be in special facilities. This is just one example of the ways in which physical space that is seemingly gender neutral can, in fact, be facilitating the success of men over women.

Other subtle cues that remind women at UVa that many STEM departments were founded by and for men were things such as the distance to an own-gender restroom, with female faculty and graduate students in the sciences needing to walk significantly further than the men (UVa CHARGE, 2015). Other studies suggest that women's sense of belonging in STEM spaces is affected by the STEM environment, and can be negatively influenced by things such as the presence of stereotypically male objects, and positively influenced by the presence of natural elements, such as curvilinear designs (Cheryan et al., 2009; UVa CHARGE, 2015).

Beyond the nature of the physical spaces, it is also possible that the gendering of the STEM space extends to less visible areas, such as the culture of STEM and the intellectual and rhetorical spaces, for example, the lack of women faculty and administrators to serve as role

models, project assignments that are designed with male interests in mind, hostility from some of the male students, professors' expectations of poor performance from women and the use of male language in classroom and laboratory spaces (Burke & Mattis, 2007). These factors lead Burke and Mattis to conclude, "women students can cope with engineering work, but not with engineering culture" (ibidem, p. 9).

This intimate relationship between space and body is one that cannot be divorced from history. How were the spaces developed? To what extent have these physical, intellectual and rhetorical spaces of STEM allowed themselves to be reshaped and rebuilt as female bodies came to inhabit them? By opening the door to women but refusing to change the spaces themselves, the onus is on the female body to adapt to the STEM space.

As highlighted in Spain (1992), the control over space represents an assertion of power. As women move into a rigid physical and intellectual space and are forced to conform to it, men assert their ability to retain and reinforce their positions within those same spaces. While rigidity may not be the defining characteristic of "male" spaces, STEM spaces have done little to change and accommodate the growing numbers of women entering STEM fields. The culture of STEM, the nature of the assignments, the lack of collegiality and the emphasis on competitiveness are all taken as givens in STEM (Burke & Mattis, 2007; Pollack, 2015). The power structures at play suggest that as STEM bodies and spaces refuse to shift, the "who we shall become together" continues to retain a masculine form.

Research Method

Many of the challenges faced by women in STEM are of a subtle nature. The gendered aspects of these challenges often go unnoticed by women as they experience them, much as they went unnoticed by me. We are taught from an early age about the objectivity of science and the scientific method, and about the neutrality of science when it comes to values, preferences and bias. I chose a hermeneutic phenomenological approach (van Manen, 2014) since it allowed me, as a researcher, to look for insights, patterns and threads of meaning in the experiences of my research participant, even as the participant herself may not necessarily have been aware that she was highlighting these patterns in her account. I did this through a descriptive and interpretive process that sought to illuminate the sources and meanings of her lived experience (van Manen, 2002; 2014).

This small-scale study was conducted with just one research participant in an effort to illuminate and highlight some of the emerging themes for women in STEM before I embark on a fuller study as part of my PhD thesis. This preliminary exploration is thus my attempt to open up this phenomenon and prepare for a fuller rendering of it.

Focusing on a student in the middle of her course rather than, for example, a woman who has dropped out, allowed me to gain insight into the experiences of a woman in STEM as it is unfolding, rather than of a woman trying to conjure up her memories of the past. The fact that my research participant is still fully immersed in the STEM world means that she can recount for me in vivid detail the events that are unfolding in her life in a pure, unfiltered way that is pre-reflexive. This opens up the nature of the pure experience, rather than thoughts, feelings or memories of the experience.

Research Participant

In order to better understand the lived experiences of women in STEM, I recruited the help of a sophomore bioengineering major on the premed track at a large public university in the Mid-Atlantic region of the United States. For the purposes of this study, I have chosen for her the pseudonym Barbara, in honor of the female geneticist Barbara McClintock (1902-1992), the first scientist to propose the theory that genes can move both within and between chromosomes.

Barbara's experiences as a woman in science can be thought of as atypical in many ways. First and foremost, she attended an all-girls' high school, which may have shielded her from some of the social pressures that adolescent girls face in the US to be "cool," to play down their intelligence, and to not be perceived as "nerdy." In addition, as a very academically accomplished applicant to university, Barbara was admitted to a competitive honors program, which offers a built in support network, faculty mentors and research opportunities to students for their first two years as undergraduates. The honors students all live together in one dorm for their freshman year, building up a residential community that enables students to "to build lasting friendships, complete group assignments for their classes, adjust to life at university, and create their first professional network," as stated on the program's website. Finally, bioengineering is the only engineering major at this university where the gender ratio is even, with female students representing approximately 50% of the student body. All of these somewhat unique circumstances may have contributed to building Barbara's confidence and resilience, and to helping her find support networks and resources that are unavailable to many other women in STEM. However, in speaking to her I gained valuable insight into the difficult experiences that face even the most talented and privileged women in STEM, while also gaining some understanding of the ways in which women are experiencing these additional support systems and structures that universities are putting in place in order to reduce or prevent the phenomenon of STEM attrition.

I had a total of two conversations with Barbara. Both of our conversations happened in a café in the Physical Sciences Complex at the university. More than a decade after my own sophomore year in college, I recognized in Barbara's descriptions of her lived experience in STEM a lot of themes that rang true to my own experience. I could imagine myself in her

lecture halls; I understood in an intimate way her feeling that she was sometimes "flailing in a sea of people;" the connection that we forged through our very first conversation helped to establish a degree of openness, trust, and shared experience that truly allowed us to be frank with each other. I am extremely grateful to Barbara for sharing her story with me and for being a part of what has been an enlightening process of discovery.

Thematic Rendition

Invisibility, Seeing and Being Seen

> We see the things themselves, the world is what we see. (Merleau-Ponty, 1964, p. 1)

In an Organic Chemistry lecture, surrounded by a sea of 350 largely unfamiliar faces, one becomes momentarily invisible. One is no longer an individual, but rather a part of a mass. The lecture hall is dim, and the glow of the screen at the front of the room, the dark, distant instructor on the stage – those become the only things that really exist in this space, as everything else disappears under a cloak of anonymity. You and the students around you become shadows. You come to realize that apart from the handful of people you are in the habit of sitting close to, no one would notice if you failed to show up one day. It is possible that even your neighbors might not notice, or that you would quickly fade from their memory if you were to skip more than one lecture in a row.

If you pay close attention you will notice that many of the students behave as though they cannot be seen. One is doing the crossword from the daily newspaper. He could easily be mistaken for someone taking careful note of what the professor is saying. Others are absorbed by the screens of their phones or laptops, which are turned to messages, Facebook or emails. In one row, a few students are collaborating on the problem set that the professor will be collecting at the end of the lecture.

There are, of course, those who choose to sit at the very front of the room. Those people are seen. The backs of their heads become familiar to those who choose to sit further back, and their faces may be the only ones the professor can actually make out in the room. Perhaps it is to them that he is lecturing to. And those students are aware of their visibility. It keeps them from using their phones; it keeps them focused and on-task because not only are they themselves more visible, the professor is more visible. His voice is louder. The slides on the screen are clearer. This is where students sit in order to better see, and be seen.

Barbara makes it a point to always sit at the front of the lecture hall, where she can see and hear better. Yet, she says, sitting at the front makes it so that she doesn't see the rest of the room, and the mass of faces behind her. She is a bit oblivious to what else is going on in the room. It is easier to pay attention, sitting up front, and she doesn't want to miss anything. She has worked too hard to be here, sacrificed too much to risk missing anything.

She attends office hours as often as she can. She likes to see her professors, to meet them one on one, to be seen by them, not as a member of a faceless crowd, but as a person. To be seen is to be acknowledged, and to be acknowledged is to be recognized. Being recognized is having the certainty that you are not, in fact, invisible. It is the certainty that, in seeing, you have also *been seen*. And in being seen, you were not just seen, but also remembered.

Barbara described to me how the people who occupy the front of the room in her lectures tend to be women, saying that it is her impression that "there is a higher percentage of girls sitting in the front." Barbara seems to suggest that the women in her science classes all feel that they have worked really hard to be where they are, and are thus very invested in getting as much as possible out of their lectures. However, it is also possible that the visibility and the *being seen* is as important, if not more important to women, than the seeing itself.

Seeing and being seen are important first steps in establishing relationships, in being acknowledged and, later, recognized. As women move towards the front of STEM lecture halls, they can appease their anxiety over remaining invisible in a space where they are not expected to be. They can begin to establish that they *are* in fact, there, because in being seen and acknowledged, their existence within that space is affirmed.

How do we go about occupying spaces where our presence is not expected? If, as Merleau-Ponty suggests, "the world is what we see," then for women seeking to establish themselves in a historically masculine space, remaining invisible is not an option. Perhaps being seen and acknowledged is an important first step for the women who enter scientific spaces. Yet the process is a difficult and time-consuming one, given the characteristics of the STEM space, which is built for anonymity and invisibility. It is important to consider how these characteristics of the STEM space might be experienced differently by women than they are by men, as women struggle for visibility as a means to assert their very existence within STEM spaces.

Recognition as Seeking Permission to Be

> Throughout life we smile back when smiled at, frown when met with a grimace…Mouth mirrors mouth, forehead mocks forehead, lips mimic lips. To have a face is to have been looked at in the face by another face. (Steeves, 2006, p. 2)

You know the professor's face but your own face remains unrecognized in the sea of anonymous faces. It takes some effort to be known. You stay after class to ask questions, you attend office hours. One day a small gesture of recognition – a nod in the hallway, the use of your first name – is an acknowledgement that you are no longer just one of the masses. To become known, to be recognized, is at the heart of the experience of *being*; it is the certainty that we *are* and can *be* in a space, in relation to others who occupy that space.

> "I talked to the director of the program and she goes "oh, did you ask questions after class?" And I go, "yeah but I don't think he'll know me," and she goes, "oh he'll *know* you." …When I walk by he acknowledges me. You know, not by name but he… you know, he kind of like, says "hello" you know? Just acknowledges me…" (Barbara)

Recognition is at the heart of acknowledgement. According to the OED, the verb *to recognize* comes from the Old French *reconoiss-,* meaning "to know again, identify, recognize," and originates from the Latin *recognoscere,* meaning to "acknowledge," "recall to mind, " or "know again." It is from *re-* "again," and *cognoscere* "know." Interestingly, there are two different forms of the verb "to know" in Latin, *novisse* and *cognoscere. Novisse* implies a superficial knowing. For example, *novisse* would be used if you *knew of* a person or had *heard of* them; *cognoscere* implies a depth of understanding and of experience with something or someone. For example in the context of knowing a person, using the verb *cognoscere* would imply that you have, at a minimum, spoken to that person, and that they too would know and acknowledge you, were you to meet. So there is a certain reciprocity implied in the word *recognize;* it is at once to know and also to *be known;* it provides a sense of being and of selfhood that can only happen in relation to others, and it reaffirms a sense of belonging. Tied in with this notion of *being*, the noun *recognition* first made its way into the English language in the 1590s to mean "a formal avowal of knowledge and approval" and in 1824, was used to connote the acknowledgement of a country's independence from a former sovereign state. To be recognized, then, implies *the right to exist*.

As women navigate their entry into STEM spaces, being recognized and acknowledged by a professor or other authority figure is reinforcing and comforting. It reaffirms their *right*

to be in a historically masculine space, even as other cues such as the gender ratio in many of the classrooms, the absence of female faculty and the dearth of female textbook authors may be providing a subliminal message that they do not belong:

> "It might not be anything more than knowing my face… When I walked by and he [the professor] smiled at me and acknowledged me…it's recognition, I could see that he recognized my face… even just knowing that he recognizes me…it's good for me as a student and it's encouraging for me when I'm in his class." (Barbara)

When our position within a space is uncertain, when we are feeling unsure of our place and whether we are welcomed, perhaps we will seek out a familiar face. We will look for someone who we know and who might recognize us, who might say hello and help us to affirm that our presence is welcome. Who has never had the experience of being uncertain about whether one belongs? Is it possible that in seeking recognition, women in STEM are attempting to affirm their right to exist in the STEM space? If so, how might the invisibility and anonymity inherent to the STEM lecture halls affect women differently from the way it affects men? How might women experience anonymity and invisibility as a declaration that they are unwelcome?

The importance of recognition was something that Barbara emphasized as being key in the relationships she had begun to develop with faculty. For example, while she claimed that she had not developed a longstanding relationship with a faculty member yet, she highlighted the head teacher in her honors program as a notable exception. She went on to explain, "he knew everybody's name you know, [from the] first week of class. And he still knows me…he was actively putting in effort to getting to know all of us, which was really good…" While for the most part the onus was on her and on the other students to seek out professors and make themselves seen and known, this professor stood out to her because he had made an effort to get to know the students and to learn their names. Barbara associated this behavior strongly with the beginning of what she called "a longstanding relationship," highlighting the importance of recognition as a reciprocal and relational construct. A professor surprising you by knowing your name on the very first week of class signals that you are welcomed and acknowledged, and demonstrates that your presence is appreciated and encouraged.

For women in STEM, recognition is therefore an acknowledgement of their rightful place within that space. To be acknowledged and recognized, even in a small, mundane way is reassuring. Within the STEM environment, however, the onus is on the individual to gain acknowledgement, and women might feel this most acutely. Why can acknowledgement not be more readily achieved in STEM spaces? Code (1995) posits that there are "structural implications of granting and withholding acknowledgement" within rhetorical spaces; in STEM, the power to acknowledge and thus grant permission to *be* is still largely in the hands

of male faculty and administrators. On what terms do they choose to grant or withhold acknowledgement? Is it not likely to remain, to this day, in male terms?

Getting to the Heart of the Matter: The experience of living in limbo

> "That's really the hardest thing, when you're trying your best but you really don't know what's really expected of you, and you're really just in…limbo, where you don't know what to do in order to be better." (Barbara)

> **Limbo (n.1)** "region supposed to exist on the border of Hell" …c. 1300, from Latin *limbo* ablative of *limbus* "edge, border"… "condition of neglect or oblivion" is from 1640s. – Online Etymology Dictionary

As women enter STEM spaces, there are many obstacles standing in the way of their moving towards the center and establishing their presence. The physical set-up of lecture spaces and the pedagogical structures of STEM tend to favor invisibility and anonymity, placing the onus on students to make themselves seen. All of this stands in the way of establishing relationships and coming into being relative to others. As a minority group in STEM, women may experience this environment as hostile or unwelcoming. For women, the lack of acknowledgement and recognition can be construed as a denial of the *right to exist* within the STEM space.

Whereas Barbara described having a "core group of girls" who tended to be in higher-level science and math classes with her in high school, at university she describes scarcely having seen the same faces in her classes from one semester to the next. This idea of the core, from the Old French *coeur* or heart, stands in stark contrast to her feeling of being in limbo, or at the margins, as she described the experience of struggling to figure out what is expected of her in her classes. The word limbo shares the same Latin root as the word "limb," and we return to the idea of STEM bodies of knowledge as spaces in which women are not invited to take on central roles.

As Casey (1993) suggests, body and space are inextricably linked, and their fates tied together. The difficulty women experience in gaining recognition in STEM spaces affects their ability to establishment of relationships that might help them move from the margins towards the center, from being at the limbs, or in limbo, to occupying the heart, or core.

Barbara herself has worked tirelessly to establish the relationships that she feels have helped her to succeed in STEM, seeking recognition and acknowledgement from her professors and also the friendship and camaraderie of her classmates and peers. Her understanding that the help of others is important to her successful navigation of these new spaces led her to claim during our conversation that "making connections with people and getting help is the most beneficial thing I could have done for myself."

Establishing relationships with classmates has been central to Barbara's navigation of STEM spaces. She tends to work in groups with other students on weekly problem sets, and described how working together, they piece together their lecture notes and textbook readings to apply their knowledge in solving problems. Alone, Barbara describes the process as "overwhelming," however in working with others, Barbara describes feeling like they are "in it together." Here again we see the establishment of ties and relationships as central to a sense of belonging within a space.

Yet Barbara periodically revisits that sense of isolation and marginalization, which is accompanied by a lot of stress. The start of each new semester requires the establishment of new relationships with new classmates, the forming of new homework groups, and the feeling of being in limbo, unsure of what to expect and how to succeed:

> "You really have no idea what it's going to take to be successful …that feeling…lasts for me through the first midterm for each class…it's stressful to take those exams when you don't know what the format is going to be…what types of questions are going to be on the exam…you really don't know what it's going to take…until you're sitting in the class and you've taken an exam." (Barbara)

Here and elsewhere during our conversation, Barbara stressed that it was only once she was *in* a class and experiencing it for herself, from the inside, that she could really determine what it would take to be successful there. Once again, the onus is on her as an individual to figure this out on her own, to navigate the space and establish for herself what the determinants of success are within that space.

If this experience of an individual class or study group can be taken to represent the analogous experience of entering the STEM space in general, what does it mean to have to first be *in* STEM before one can understand what it takes to be successful? As women enter the space, they are expected to navigate the process on their own as if they were already on the inside, sitting comfortably in the inner core. How might someone who is already at the metaphoric center of that space experience that very same endeavor differently? And how does the difficulty of forging lasting relationships within STEM create a structure whereby the experience of aloneness and isolation at the margins repeats itself cyclically?

While it is possible that all new scholars begin at the margins of science, regardless of their gender, it is still likely that women experience being at the margins differently from men. Perhaps women are more acutely aware of their position at the margins, or perhaps they have a greater tendency to experience self-doubt, as a result of socialization, or as a result of other subtle messages that they have internalized, which have repeated that women do not belong in STEM. Either way, it is telling that even while Barbara took the necessary steps to be seen and acknowledged, and formed important and meaningful connections to professors, administrators and classmates, she still experienced moments of self-doubt and uncertainty in the past year and a half of college life as a STEM major:

> "Even though I have this group of people that [sic] we do the work together, we complain about it together…there's still times when I'm like, there's no-one that's…as inadequate as I am... There's no-one that knows as little as I do… I…have doubts about whether I'm equipped enough to make it through." (Barbara)

Coming from an exceptional student who was selected for a competitive honors program where she receives additional supports, this self-doubt is worrying because it suggests that other women are likely to experience at least some version of it during their time in STEM. If even extremely accomplished and successful female scholars in STEM are questioning their ability to "make it through", we need to be asking ourselves more seriously what it is about these spaces that make women feel so vulnerable.

Insights

> Knowledge is in the end based on acknowledgement. (Code, 1995, p. x)

Exploring the experiences of women in STEM phenomenologically has led to a wealth of new insights into the subtle ways in which body, space and gender interact within STEM. In examining the experiences of women in STEM, it becomes impossible to distinguish between the embodied experiences of visibility versus invisibility, and the spatial and relational experiences of gaining access to the center versus remaining at the margins, and remaining alone versus becoming a part of a group. As women enter STEM they experience STEM spaces, both physical and otherwise, in unique ways. I do not seek to explain why this is, but simply illuminate the phenomenon. To acknowledge it is, perhaps, the first step in addressing it.

To women entering STEM disciplines, visibility, acknowledgement and recognition are integral not only to establishing their presence within the space, but to establishing their *right to be* within the space. As such, the experience of invisibility, anonymity and isolation that are so pervasive in STEM can be perceived by women as signs that they are not welcome.

Even as the onus is on women to navigate STEM spaces as if they were already insiders, the experiences of women demonstrate that the metaphoric journey from the margins to the center of STEM spaces is a difficult one. Not only that, but the structures of STEM create the need for the journey to repeat itself; at the start of each new semester, with every new class, visibility and acknowledgement need to be sought again, new relationships must be forged, and new study groups formed. The feelings of stress, isolation and of being in limbo, once again relegated to the margins, are also revisited. Returning to the word "attrition," it has been possible to see through this investigation the subtle and repetitive ways that STEM spaces might be wearing away at women.

As we strive to make STEM spaces more gender equitable, it is important to make visible the ways in which the very same environment can be experienced differently by different genders. Specifically, the themes unveiled in this investigation suggest the need to explore the ways in which STEM spaces perpetuate invisibility, anonymity and a sense of marginalization, to the detriment of visibility, recognition and relationality. The latter have emerged as key elements in making women feel welcomed, accepted and capable of navigating STEM, and yet they are each at odds with the very ways in which STEM spaces are constructed and maintained.

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Romina B. da Costa is a PhD student in International Education Policy at the University of Maryland, College Park. Her focus is on STEM education with an emphasis on gender issues in STEM. Romina employs qualitative research methods in education, especially ethnographic and phenomenological approaches.

Contact: rcosta2@umd.edu