Chapter 1

Introduction

We all have math stories to tell. The discipline pervades our understanding of who we are. We tend to relate to mathematics in a much more intimate way than we do to most other disciplines. Whether we hated it or loved it, very few of us have neutral feelings about the field. My own math story is no exception. My relationship to mathematics has never been easy, nor has it been consistent; sometimes I hated math and did not think I could achieve success. Sometimes I loved mathematics with so much passion I could not imagine doing anything else with my life. My earliest memory of mathematics is of attending a remedial math class during the summer after kindergarten. I remember asking my mother what "remedial" meant. By third grade, it was well established that mathematics was not one of my strengths, and when I transferred to a new school, I was tracked into the lowest-level math class. In middle school, I began to do better in mathematics, and I discovered, to my surprise, that I enjoyed it. After doing well on a competency test and achieving high marks in class, I told my eighth-grade math teacher that I was interested in enrolling in the honors section of high-school algebra. She told me that was probably not a good idea and encouraged me to enroll in a nonhonors section. I chose not to listen to her. During my sophomore year of college, I declared an undergraduate major in mathematics after a chance conversation with my calculus professor, who told me I was very good at mathematics and that I seemed to have a natural talent. I went on to earn a bachelor's degree in mathematics and graduated with honors, after completing my senior thesis in knot theory. Yet I chose to pursue a doctoral degree in feminist studies rather than mathematics, in large part because I never really believed that I could become a mathematician.

My own math stories are not uncommon; many have had similar experiences. The scholarship on pedagogy in the mathematics classroom shows, time and again, the impact teachers have on the students in their classrooms. Experiences like mine—the discouraging middle-school teacher or the professor who offers a word of praise—certainly play a role in determining whether a student succeeds in math. But mathematical success depends on more than just what happens in the classroom. In this book, I argue that our relationship to mathematics develops in a complex cultural context and that we need to move beyond the classroom if we want to understand the ways that mathematical success has been limited to a very select group. While my own classroom experiences have had a profound impact on my successes and failures in mathematics, it was only when I started to understand those experiences within a larger cultural and intellectual context that I gained insight into how my own relationship to mathematics influenced my decision to leave the field. What follows is a series of vignettes, each one a discrete remembrance from my intellectual life that has shaped how I think about mathematics. These moments circulate around the writing of this book, continually reemerging, reinscribing what I think I know, and helping me to reimagine my own relationship to mathematics and to the intellectual work that I do.

When it comes to mathematics, it is very easy to get caught up in the familiar discourse that constructs mathematical ability as something with which we are born. Someone is either good at mathematics or not. Within that discourse, there is no way to tell a story about success in mathematics that involves hard work and multiple failures before arriving at that moment of understanding and insight. And yet, that is my story. One of the most profound memories I have of my undergraduate mathematics education is of failing multiple times, almost to the point of giving up and changing my major. At the small liberal arts school where I did my undergraduate work, the course that separated the math majors from everyone else was linear algebra. If you could succeed in linear algebra, you could succeed in the mathematics program. In that class I was exposed to abstract mathematical reasoning and proof writing for the first time and I struggled with the work during the first part of the semester. I would wrestle with homework every night, convinced that I would not succeed as a math major. I simply could not wrap my head around the mathematical work that I was attempting to do. During every scheduled office hour, I joined my fellow students, sitting on the floor of my professor's office while he ran mini-tutorials. We brought him our questions and he would explain how we should proceed. It was the only way I could get through the homework. About six weeks into the semester, I was on the verge of dropping the course and changing my major, when things turned around for me. After struggling through so many weeks, unable to complete the homework without significant help from my professor, I was suddenly able to understand the problems and proofs that I encountered in our textbook. It was like a click inside my head—a light switch turned on in a room that had previously been dark. Suddenly I could do linear algebra; I understood how to approach the work and move through it. I still had to work hard. But I was now swimming in clear, cool water, and I could see everything in front of me, rather than the murky, muddy blindness that I had been experiencing during the first weeks of the semester. That moment taught me many things: the thrill of succeeding after hard work, the seduction of mathematical clarity, the beauty of mathematical rigor. I enjoyed mathematics before that moment, but I truly loved it afterward.

The experience that I had in linear algebra shaped my understanding of intellectual labor in general. It was a moment I remembered in graduate school as I struggled to understand difficult feminist and cultural theory. I knew that if I kept working at it, the reading would get easier and comprehension would not require so much time and toil. When I teach theory to my students, who are often frustrated by academic writing they consider difficult and unnecessary, I tell them about this moment in my linear algebra class—the hard work that came before it, the multiple failures and the fact that I didn't give up, and the moment the light turned on in my head. It has helped me to understand that intellectual ability is not necessarily something that only some of us are born with, as our society likes to tell us; rather, it is something all of us can continually work to improve, whether we are struggling to understand the proof of a mathematical theorem or the dense cultural theory of Deleuze and Guattari.

Education scholars have found, however, that our perception of natural ability versus hard work is gendered, especially in mathematics. Female students claim that they are not really good at mathematics because they always have to work so hard to succeed. Male students do not discuss how hard they work; instead they claim their success in mathematics just comes naturally (Mendick 2005). In addition to preventing girls and women from understanding themselves as mathematicians, the perception that mathematical intelligence is a natural ability can serve as a stumbling block for marginalized groups when they find they need to struggle to understand. The easy assumption, made by both the individuals themselves and by the wider culture that surrounds them, is that they are simply bad at mathematics.

I graduated from college with a double major in mathematics and women's studies. I received honors in both fields and was urged to apply to graduate school by both my math professors and my women's studies professors. I loved both mathematics and women's studies, but the decision to apply to a newly established feminist studies PhD program was easy, despite the numerous warnings I received about the illegitimacy of interdisciplinary doctorates. I had spent the last four years experiencing the camaraderie and the competitiveness of my fellow math majors. I had been a bit of an anomaly, one of just four women in the program. The male students with whom we shared office space often tried to prove they were better at mathematics than we were. In general, they were no more successful than I was at mathematics, but what I remember most about that atmosphere of competition is the confidence the men had in the performance of their work, whether or not the end result was actually correct. It was a confidence I completely lacked, despite consistently achieving higher grades than them; I was always convinced that they knew more, that they had more talent than I did. I both loved and hated the time I spent in the math student offices as an undergraduate. The camaraderie was there and I enjoyed it. I liked working collaboratively on difficult math problems, but I was exhausted by the competitiveness, both subtle and overt, that was almost always present. When it came time to make a decision about graduate school, the prospect of five to seven more years in a similar environment pushed me toward women's studies.

I loved mathematics and I was good at mathematics; I was also certain I did not have what it took to be a mathematician. It is important to note here that I had very supportive mathematics professors, who encouraged me and helped me to succeed in my undergraduate courses. Most of them were very aware of the gender disparities in their field and worked to encourage women in their classes. I thrived in my program, and I was successful. Despite my numerous achievements throughout my undergraduate career, however, I remained scared and my fear paralyzed me. During my junior year my advisor encouraged me to apply to the Budapest Semester in Mathematics, a prestigious study abroad opportunity to learn mathematics from leading Hungarian mathematicians. I looked into the program and decided not to apply because I did not think I would be accepted. During my senior year, I became convinced that I could not pass the subject GRE exam in mathematics, and as a result, I did not apply to the mathematics graduate programs that my professors encouraged me to look into.

Many years later when I read the work of education scholars Heather Mendick, Melissa Rodd, and Hannah Bartholomew, I found my undergraduate experiences mirrored in their interviews with female mathematics students in England (Mendick 2005; Rodd and Bartholomew 2006). Mendick found that high-achieving female mathematics students were unable to see themselves as "good" at mathematics and none of them described themselves as mathematicians. Rodd and Bartholomew found similar results; female math students would explain away their mathematical achievement as merely the result of hard work; they would sit quietly in class rather than demonstrate their knowledge via class participation. They became, in effect, invisible mathematics students, quietly absorbing knowledge while at the same time denying their success. Mendick echoes the conclusions of Valerie Walkerdine (1998) when she argues that female math students have a difficult time reconciling their femininity with their success in mathematics. In our culture, femininity and mathematical talent are discursively incompatible. We simply cannot reconcile the cultural construction of femininity with the construction of mathematical subjectivity. This is reflected in interviews with female mathematicians, many of whom are extraordinarily successful in their field, but nevertheless do not consider themselves to be real mathematicians (Damarin 2008). The work of the above mentioned scholars gave me insight into my own experiences and helped me to understand the choice I made to pursue a graduate degree in women's studies, rather than in mathematics.

Of course, other factors played a role in my decision. Now, as a women's and gender studies professor, I like to ask my upper-level students about their feminist "aha" moment and I tell them about my own moment of revelation: a single book changed my life. I was nineteen years old, enrolled in my first women's studies course, and the feminist argument in that book radically shifted the way I understood myself, the world around me, and my place in that world. When I chose to pursue a doctoral degree in women's studies I remembered that "aha" moment and I committed to creating moments like that for my future students. My experiences in all the various roles I occupy make more sense to me when I examine them through the lens of feminist theory. Philosophers Maria Lugones and Valerie Spelman argue that, "We can't separate lives from the accounts given of them; the articulation of our experience is part of our experience" (Lugones and Spelman 1983, 574). It was during my undergraduate education that I came to realize the great power inherent in being able to articulate one's own experience, in order to make sense of that experience and to shape that experience.

It was in my attempts to articulate my experiences as an undergraduate mathematics student and to connect my mathematics education with feminist theory that the seeds of my current interdisciplinary intellectual work were planted. During my senior year of college, I did an independent study on psychoanalytic theorist Jacques Lacan and ended up writing my final paper on the connections between mathematical topology and Lacanian theory. I wrote my women's studies senior thesis on feminist pedagogies in the mathematics classroom and the ways in which feminist approaches to teaching math allowed marginalized students to understand and work with mathematical knowledge in innovative new ways. I continued this work in my doctoral dissertation, where I made the epistemological argument that mathematical ways of knowing are shaped within communities, using a series of historical case studies to support my argument. And, now, in this book, I consider the cultural construction of mathematical subjectivity and argue that mathematics plays a significant role in the construction of normative Western subjectivity and in the constitution of the West itself.

The West understands itself in relation to mathematics; all of us can readily talk about our relationship to mathematics. Whether we loved it or hated it, I would argue that each of us relates to mathematics more closely than we do to most other disciplines. This relationship to mathematics manifests itself not only at the level of the individual, but at the cultural level; mathematics plays an important role in how we conceptualize ourselves. The growth of mathematical knowledge has been called the greatest feat of humanity. It is considered by one mathematician-historian to be "the mother of all science on which one finds the foundation for productive imagination, and of clear and fine thought, as well as criteria for and prototypical examples of objective truth in all intellectual activity" (Artemiadis 2004, *vii*). We define ourselves as human and as civilized by pointing to mathematics; we understand ourselves in relation to mathematics. Many of us even understand the knowledge we produce in relation to mathematics, no matter what our disciplinary affiliation is. It is "one of the major forces behind the creation of the modern world, and one of the central strands of human intellectual activity" (Stewart in Mankiewicz 2000, 6). Where does the intimacy of our relationship to mathematics come from? Why does mathematics figure so prominently in our cultural self-conception?

Rather than looking directly at mathematical knowledge, this book addresses the question of where and how we get our ideas about mathematics and about who can engage with mathematical knowledge. There have been a wide variety of debates in the philosophy of mathematics during the past few decades, about the nature of mathematical knowledge itself, the metaphysical status (or lack thereof) of mathematical truth, and the value of mathematical proof (Tymoczko 1998). These debates are valuable insomuch as they expand epistemological analyses of mathematics beyond the traditional analytical focus on logic and foundations, but they also serve to limit discussions about the field of mathematics to a very small community of philosophers and mathematicians. What I am interested in, rather, is a cultural studies approach that considers how our ideas about mathematics shape our individual and cultural relationship to the field. Specifically, I am interested in the ways stories about mathematics contribute to the construction of mathematical subjectivity and the role mathematical subjectivity has played in the development of the West. I am using the term *subjectivity* in the Foucauldian sense and examining the ways the mathematical subject is constituted via discourse. Michel Foucault (1972) writes in *The Archaeology of Knowledge* that discourse is not just a set of signs signifying objects but "practices that systematically form the objects of which they speak" (49). According to Valerie Walkerdine (1990), "we might understand subjectivity itself as located in practices, examining the discursive and signifying methods through which a person becomes 'subjected' in each practice" (51). Mathematical subjectivity, I argue, is formed not only via the practice of mathematics itself, but via the practices that constitute our cultural understanding of mathematics in the West.

In this book, I consider four locations in which representations of mathematics as a field of study contribute to our cultural understanding of mathematics—mathematics textbooks, history of mathematics, portraits of mathematicians, and the field of ethnomathematics. I have chosen these four areas because they are all intimately tied to the field of mathematics through education. We learn about what mathematics is from our math textbooks, from the histories we tell of the field and the images we have of great mathematicians, and from cross-cultural examples of mathematical practice. Not only do these areas contribute to our general cultural understanding of mathematics in the West, but, I would also argue, mathematics as a field of knowledge gains a sense of itself via the ways it is taught, the history of its development, the images we have of its greatest practitioners, and its relationship with non-Western mathematical practices.[1] Analyzing these four locations allows me to trace the relationship between the construction of mathematical subjectivity and the much broader construction of the subject in Western culture and of the West itself.

Mathematics is central to our cultural self-conception, which becomes clear in the various ways we talk about mathematics and in the stories we tell about the field. In the chapters that follow, I argue that mathematical subjectivity is constructed in ways that limit access to select groups of people. The stories that we tell about mathematics both underlie and work to reproduce the discursive construction of the normative subject in Western culture. This intimate relationship between mathematical subjectivity and normative Western subjectivity is why many educators understand achievement in mathematics to be a "gateway" to success in the world (Ladson-Billings 1997). How do these mathematical stories shape our cultural relationship to mathematics? In what ways do these stories help us, as a culture, to think about ourselves as human, as rational, as modern? How do these stories shape individual mathematical experiences? How do we negotiate the mathematical discourses that circulate in our culture in order to establish our own mathematical subjectivity? What function do these stories serve for those individuals who have felt excluded from mathematical knowledge production?

There is a widespread awareness in our culture that racial and gender disparities exist in mathematical achievement and in the pursuit of mathematical study and careers (Brown-Jeffy 2009; Lim 2008; Caplan and Caplan 2005). Research on women's relationship to the field of mathematics has been fairly extensive and efforts to address the achievement disparities between men and women by reforming mathematics education have met with some success. Recent research shows that girls' achievements in mathematics stay on par with boys through secondary school. There remains, however, a significant disparity between young men and young women's participation in and success in mathematics at the postsecondary level, leading to what many now call the "leaky mathematics pipeline" (Oakes 1990; Watt, Eccles, and Durik 2006). While some still argue that women and men have different aptitudes for mathematics, many researchers have concluded that sex differences in aptitude and achievement in mathematics are minimal. In a 2005 critical review of such studies, Jeremy Caplan and Paula Caplan argue that meaningful sex differences in mathematical ability have never been found and that when such differences are found they are "massively confounded with factors related to individual experience" (Caplan and Caplan 2005, 42).

If differences in aptitude and ability do not necessarily force women out of mathematics, then what experiences do young women have in the field and in our wider culture that cause them to leave mathematics at the undergraduate, graduate, and professional levels? Researchers have examined women's experiences within the classroom and in professional settings in an effort to understand why and how young women become alienated from mathematics. The most interesting manifestation of this work looks specifically at how our culture constructs both gender and mathematics in ways that ensure that girls and women have a difficult time understanding themselves as mathematicians (Walkerdine 1998; Mendick 2005; Rodd and Bartholomew 2006). Valerie Walkerdine, one of the first to make this argument, says that "the proof of masculinity as rational, as possessing knowledge, as superior, has constantly to be reasserted and set against the equal and opposite proof of femininity's failure and lack. This is not to collude with the idea that women . . . really 'are' lacking, but to demonstrate the investment made in proving this. Such 'proof' is based, in this analysis, not on any easy certainty, but on the terrors and paranoias of the powerful . . . Girls do not grow up to autonomy but on one side of a sexual divide already replete with myth and fantasy . . . The struggle girls face is not easy" (Walkerdine 1998, 97). More recent research confirms this argument; findings suggest that young female mathematics students feel forced to choose between their femininity and their identity as mathematicians, putting them in what seems to be an untenable position. Some have argued that this may be one reason young women who have achieved great success in the field nevertheless drop out of mathematics after secondary school (Mendick 2005; Rodd and Bartholomew 2006).

Research on race-related disparities in mathematics education and achievement has lagged behind research on gender-related disparities. Particularly in the United States, the implementation of the No Child Left Behind Act in 2001 has caused an upsurge in research on the persistent achievement gap between white students and African American, Hispanic, and Native American students. Efforts are being made to teach a more culturally responsive mathematics curriculum (Stinson 2004; Ladson-Billings 1997), but these efforts have been largely unsuccessful. Some scholars report that the achievement gap in mathematics between whites and ethnic minority students has stabilized or even widened in the U.S. since the 1980s (Lim 2008).

While the focus in the vast majority of studies has been on this achievement gap, some researchers are calling for a more nuanced look at the phenomenon, arguing that such a focus continues to construct white, male performance in mathematics as normative (Martin 2009). David Stinson's work is a powerful example that shifts the focus away from the achievement gap and offers great insight into how African American mathematics students achieve success. In one of his recent publications, Stinson's research on how African American students must negotiate what he calls the "white male math myth" demonstrates that African American students face a series of cultural discourses that work to limit who can understand themselves as mathematical knowers (2013). Erica Walker also makes a powerful argument that "one's mathematical identity might have to be reconciled with one's core identity—be it ethnic, gender, or otherwise," and that students of color have to, at times, compromise their ethnic identity to fully embrace their academic identity (2012). In much the same way that feminist education scholars have shown, via discourse analysis, the incompatibility between femininity and mathematical achievement, Walker and Stinson show the complex ways that successful black mathematics students must accommodate, reconfigure, or resist the discursive construction of a normative white, masculine mathematical subjectivity.

While the use of postmodern analyses in mathematics education research has become a powerful voice in debates about how mathematics curricula and pedagogies should be reformed (see, for example, Walshaw 2004; Stinson and Bullock 2012; Brown 2011), there has been very little work in either women's and gender studies or in science and technology studies that brings together cultural studies, postmodern theory, and mathematics. As a result, there is almost no discussion in women's and gender studies about mathematics, and only peripheral discussion of mathematics in science and technology studies. This book addresses the absence of discussion about mathematics in these two fields. Using a cultural studies approach, I study the various ways that we as a culture come to know the field of mathematics. Each chapter of this book considers a different area where knowledge about mathematics is constructed: mathematics textbooks, the history of mathematics, mathematical portraiture, and ethnomathematics. I examine how these areas construct a normative mathematical subjectivity that limits the way marginalized groups are able to see themselves as practitioners of mathematics. Not only does a normative mathematical subjectivity limit the ability of women and people of color to succeed in mathematics, it limits their access to full subjectivity in general. My overarching argument is that a normative mathematical subjectivity is intimately tied to the construction of Western subjectivity and to the construction of the West itself. Many understand mathematics to be separate from human concerns and call mathematical knowledge value-free. I argue that we cling to this understanding of mathematics—a rational, universal system that relies on logic to arrive at truth—because it is a key component of how the West understands itself. By the end of the book, I show how central mathematics and mathematical subjectivity are to the construction of the West itself.

I begin to build this overarching argument in chapter 2, in which I consider the argument that mathematical subjectivity is incompatible with cultural constructions of femininity. To do this, I examine the recently published series of mathematics books aimed specifically at young girls, written by the actress and mathematician Danica McKellar. I compare the content of McKellar's books to that of two highly rated middle-school mathematics textbooks. Using discourse analysis, I analyze examples and problems from the textbooks and from McKellar's books to better understand how these texts position girls in relation to mathematical knowledge. I am particularly interested in the role mathematics textbooks play in constructing a normative masculine mathematical subjectivity and how McKellar's books may or may not challenge such a construction. The question that drives my analysis in this chapter is whether it is possible, given current cultural understandings of mathematics that emerge in both popular and educational discourse, for women and girls to understand themselves as mathematical subjects.

In the third chapter of my book I consider the history of mathematics. In what ways do histories of mathematics help us to think about ourselves as human, as rational, as modern? Who is invited to see themselves within these histories and who is excluded from these histories? In this chapter, I argue that normative understandings of Western subjectivity depend on the construction of a masculine, white mathematical subjectivity. I look at changes in the historiography of mathematics over time and show how different approaches to the writing of the history of mathematics have influenced the construction of mathematical subjectivity. In particular I examine the recent trend in history of mathematics textbooks to utilize a more biographical approach and the trope of the hero to tell the story of mathematical knowledge development. I show how this approach to the history of mathematics is intimately tied to normative constructions of Western subjectivity.

In chapter 4 I extend my focus on the history of mathematics to include the portraits of mathematicians found in two well-regarded history of mathematics textbooks. I consider the style of these portraits, their placement and use in the textbooks, and the ways in which they are integrated into the history of mathematical knowledge production. Portraits of mathematicians serve a rhetorical function: they are a depiction of heroism, individualism, subjectivity, and Western rationality. They help establish the public status of the discipline by drawing on a specific visual rhetoric associated with the portraiture of great leaders and heroes. In this way, portraits of mathematicians communicate an ideal of Western rationality and citizenship, one that defines what it means to be human and that limits who is allowed to see themselves within that ideal. In the first textbook, I argue that the style, choice, and placement of the portraits serves to reinforce a normative mathematical subjectivity. The second history of mathematics textbook I consider uses images of mathematically themed postage stamps. I show that by choosing to illustrate a history of mathematics textbook with postage stamps, many of which include a portrait of a mathematician, a connection is made between mathematical subjectivity and the development of the West as an imperial power.

The ties between mathematical subjectivity and the various imperial projects that have come to constitute the West are crystalized in the fifth chapter. I consider the field of ethnomathematics and examine how this field of study perpetuates the dominance of Western ways of knowing in mathematics. Ethnomathematics is defined as the study of mathematical concepts and practice in small-scale or indigenous cultures. While the intent of most ethnomathematics scholars is to challenge the dominance of Western mathematics by revealing how mathematical knowledge production takes place outside the academic and professional mathematics communities of the West, I interrogate the role ethnomathematics plays as the mathematical "Other" to normative constructions of Western mathematics. I show how ethnomathematics actually perpetuates the idea that the only universal, rational approach to mathematical knowledge production takes place in the West, thus limiting the very plurality that ethnomathematics scholars strive to demonstrate. Through the lens of ethnomathematics scholarship, I demonstrate how a normative mathematical subjectivity has become central to the construction of Western subjectivity and of the West itself.

I conclude this book with a consideration of the kind of scholarly work that is needed to challenge normative constructions of mathematical subjectivity. We need to tell different stories about mathematics to expand our cultural understanding of who can engage in mathematics. We also need to critically interrogate the central role mathematics has played in the various imperialist projects that have come to constitute the West. Multiple ways of knowing and understanding mathematics are needed to broaden the scope of mathematical subjectivity, to delink it from Western imperial projects, and to ensure that the opportunity to engage with mathematics and mathematical knowledge production is not limited to a select few.