Kindling the Fire: Why I Do

I have no difficulty imagining an anthology of the most beautiful pieces of world poetry where there would be also a place for the Pythagorean theorem; in it there is that illumination that is inherent to great poetry, and a form carefully reduced to the most essential terms, and a grace that is not granted to all poets.
(Wislawa Szymborska, Polish poet, Nobel Prize in Literature 1996, in *Nonrequired Reading*)

The more I reflect about my journey as a teacher, the more I realize how many people and events have inspired, guided, and shaped my experience—a finely woven web of connections of which I can start to unravel just a few strands, and just barely. Yet all of these converge to explain where I am now and why I do what I do: teach mathematics in an all-girls school.

I am a third-generation teacher. My maternal grandmother was a teacher in a one-room school that served several villages in a hilly region of the central part of Italy. Simply called *la maestra*, she was "the teacher" for quite a number of children and families over a long span of time.

My mother taught mathematics and science in public middle school, and I can still picture her in the early morning hours checking her students' papers with a red pen in one hand and a cup of steaming espresso in the other. Year after year, her first two weeks of summer always involved spending huge amounts of time with a very large sheet of paper, constructing the schedule for the entire school for the following academic year. She

This author tries to teach young women to break out of the stereotypes and understand, master, and enjoy the relevance, power, and beauty of mathematics to the fullest.

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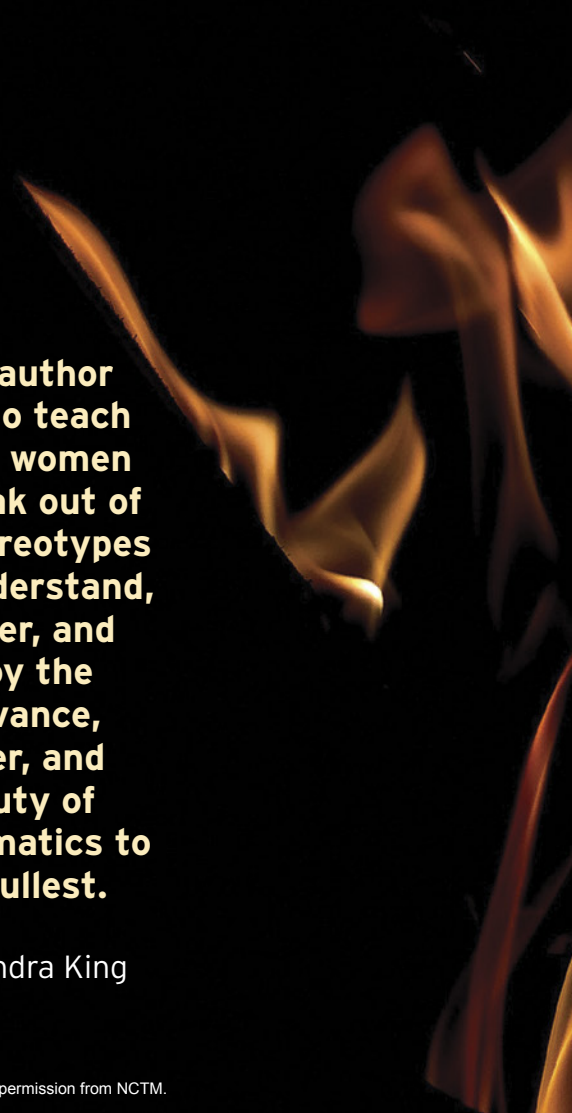

What I Do

was not paid for this extra duty: After all, this was just what a math teacher would do for her school. And she cared deeply about her students—once we even took one into our home for several months, until his grandparents could step up and take him in, and we kept in touch with him until he graduated, found a job, and got married. And so I grew up in the "shop" of master craftswomen and could observe firsthand the fundamental tools of the most important, most uniquely human of all crafts. Teaching, I found out, is a little bit like wine making, in that it has some important methods and best practices but no hard, set recipe; it depends on so many imponderables, just as wine making depends on the weather, the crop, the soil, and the water.

I was blessed with a succession of very good teachers, and more than a few exceptional ones, each extraordinary in his or her unique way. There was Suor Pierina, who made skip counting so much fun and asked us to write mathematics answers in sentences and keep our work neat, structured, and looking good, like a work of art. Mr. Branchesi, a boisterous professional painter and children's enthusiast, made each day of school a joyful intellectual adventure and never required us to memorize the multiplication tables. To this day, it is a mystery to me how and when I learned them—perhaps by pattern recognition, mental math, and frequent use? All I can say is that I knew them when I needed them. Mr. Castagnari was a wiry, reserved man for whom teaching math was serious business and whose faith in our ability to learn was so steady and deep-seated that he boosted our confidence and pushed us to excel in those critical middle school years. Mrs. Galdenzi, a southerner with a strong

Neapolitan accent, taught math in a Milanese school. Her content knowledge, huge heart, and impressive teaching abilities won everybody over, starting with her students. Ms. Santagata, our high school math and physics teacher, ended each and every day of school covered in chalk dust from head to toe. Her precise language; high expectations of abstract reasoning; and profound, multifaceted, open-ended questions astound me to this day. Each of these individuals, and the others I do not have time to mention here, embodied and modeled one or more aspects of great math teaching. They gave the gift of inspiring "joy and wonder" (NCTM 2018) with passion for their subject, dedication to their profession and their students, creativity and playfulness, deep and thoughtful content knowledge, ability to tell a story, and pedagogical suppleness.

Teaching and learning—and specifically mathematics teaching and learning—is "part of a complex system of . . . traditions and societal expectations" (NCTM 2018). Not until I moved out of my sheltered experience and went to live and teach math and physics overseas, in the Philippines first, and then in the United States, did I discover that girls are not supposed to be that good at mathematics. This realization came as a surprise, as math had always been my favorite subject, and consequently I had always done well in it. In my family, academic expectations were the same for the daughters as for the son. I had not noticed any difference in my school years. When I was a physics major in my hometown college, many (although not most) of the students in my mathematics and physics classes were women. My thesis adviser was also a woman; I had asked her to advise me because she was the only professor who studied extragalactic active nuclei, not because she was a woman. And I am sure she accepted me because I was a fair bet for a paper. As far as I knew, success in mathematics depended on the individual's personal talents, not his or her gender.

Boy, was I wrong. The news was finally delivered in full by the new Barbie™ doll who declared in no uncertain terms, "I hate math." At that time I had two daughters, a toddler and a baby, and decided on the spot to ban Barbie from our house. The embargo caused many a conversation and some arguments—with my daughters, their young friends, and their parents—and more than a few awkward moments. And it was ferociously applied for many years, until the high cost of its enforcement in time and effort made it, like all embargos, untenable.

That was not the only way we fought what later became known as the "stereotype threat" (Steele 2011). We built Lego® structures, snow forts, and marble sand tracks; played Blokus® and Mastermind®; looked for patterns in the maps of the cities we visited; rode the simulator and touched the moon rock at the National Air and Space Museum; and raised tadpoles in a bucket. We sorted, counted, and classified; transformed recipes to feed our growing family; admired the symmetry and proportions of paintings, monuments, and architectural landmarks; saw interesting buildings as complex shapes; recognized patterns and created new ones as we learned to quilt; measured, calculated and converted three-dimensional (3-D) objects in 2-D when we tried sewing. And with the inspiration and guidance of some phenomenal mathematics and science teachers (Lappin-Scott 2017), my daughters created budgets with their future first salary, played the stock market, designed and tested roller-coasters, assembled a Foucault pendulum (a sand-filled soda bottle hanging from the ceiling of our garage), and built their dream school with plywood and Styrofoam® in their geometry class. No wonder one of them, in her application to a magnet high school, wrote how much fun she had in third grade when she "first learned how to add, subtract, multiply, and divide fractions." I cannot wait to play some math with my soon-to-be-born granddaughter!

The Barbie doll incident was just the tip of the iceberg. The environment in which our girls grow and learn mathematics can affect the way they see themselves (Boaler 2015) as students of mathematics (or of any hard science, such as physics, often called the gateway for STEM careers). Although we have made progress, the same condescending attitude toward women in math, science, and technology resurfaces every now and then, in unexpected places or occasions. It appeared when my daughter, one of only two girls in her fully enrolled Advanced Placement Physics class, heard her class addressed as

PREVIOUS PAGES AND LEFT: ALDO PRAKASH/UNSPLASH

"Gentlemen." Or when, as a mathematics major in college, she was asked again and again if she intended to go into math education. That question was never asked of her male classmates. It reemerges in the far too common habit of steering our girls to dad for help with the math homework. It materializes in many a conversation when too many women publicly state, "I was always bad at math," (Eccles and Jacobs 1986) whereas an equivalent statement about reading would hardly be socially acceptable. It shows in "the soft bigotry of low expectations" (Bush 2000) with which sometimes we as educators are tempted to lower the standards—even unintentionally—to make our girls "feel good" about their mathematical achievement.

Girls do not need extra help to learn and enjoy mathematics. They need only a level playing field and a culture that, instead of subtly undermining their confidence, bolsters their efforts. We have made and are continuing to make progress, slowly but surely. The movie *Hidden Figures* (Shetterly 2016) sends a very different message and presents inspiring female role models engaged in great mathematics and exciting work. In the last few years some children's books on women mathematicians, such as Sophie Germain, Ada Lovelace, and Hypatia, have been published, and there is an effort to make more gender-neutral STEM toys. And the world also celebrates mathematics in the work of Maryam Mirzakhani, the doodles of Vi Hart, the books of Eugenia Cheng, and the talks of Hannah Fry.

As for teaching mathematics, I take my cue from a statement attributed to the poet de Saint-Exupéry:

> If you want to build a ship, don't drum up people to collect wood and don't assign them tasks . . . ; rather, teach them to long for the endless immensity of the sea.

To me this means seizing all opportunities to engage my girls with the beauty, excitement, and "unreasonable effectiveness of mathematics" (Wigner 1960). And so we collaborate on interdisciplinary projects (King 2014c, d, e, f, h; 2015a, d; 2016; 2017d; 2018a), challenging problem-solving tasks, and hands-on activities. We explore unusual, intriguing topics like fractals and taxicab geometry (King 2014a, g). We work together on Fermi questions (King 2014b, 2015c); we celebrate numbers any time possible; we play Sudoku, 2048, and FlowFree (King 2017c). We contemplate the Pythagorean theorem and its many extensions and connections, sharing its story all the way to Fermat's Last theorem. We develop the quadratic formula the historical way, as an extension of completing the square and program our calculators to do it for us. We place the concepts we study within the rich tapestry of the history of mathematics, which helps us realize that such concepts were developed through years and sometimes centuries of hard work, partial success, sacrifices, trials, excitement, adversities, and delight; and at the same time appreciate that we are taking part in one of the most creative human endeavors (King 2013; 2017a, b). We use Instagram to highlight the mathematics around us (King 2018c); we blog about contemporary women mathematicians and their work on International Women's Day (Algebra 2 Class 2018); and we write about the innumerable applications of math in our daily life (Algebra Classes 2018). We connect concepts, ideas, theories, and models; solving problems in a variety of ways and rejoicing in the diversity of our thinking processes; we organize the Problem of the Cycle (King 2015b) and the Math Squad; and we go on math trails (King 2018b).

I expect my girls—whether my daughters or my students—to tackle challenging problems and be creative problem solvers. I expect them to face engineering projects, solve puzzles, and read articles and magazines related to math. I expect them to compete in math meets. I expect them to talk about math, ask questions, and take intellectual risks. I expect them to work hard, persevere, and learn from the mistakes they may make. I expect them to enjoy math, to be successful in math class, and to carry their quantitative thinking for life. I expect that because I. Know. They. Can.

The environment in which our girls grow and learn mathematics can affect the way they see themselves.

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