How I Became a Mathematician

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The thing that made me particularly mathematical as a child was that I could always find four-leaf clovers. Whenever I saw a mass of round, green leaves in the grass, I'd study the patch, reach down, and pull up a four-leaf clover. This was a talent with a limited future, but I was proud of my ability to acquire and dispense talismans of good luck. When asked, I offered my playmates complex, quasi-mathematical explanations of how I located the four-leafs. In private I wondered what attracted my attention, other than that I considered myself the queen of good luck.

The third of eight children, I grew up in Schenectady (NY). My mother met our needs while introducing color and shape into most of our activities. She also taught us five girls how to sew with an original flair. They say creative tendencies skip a generation, and they're probably right, because I'm much less artistic than my mother or my 13-year-old daughter.

Indeed, it was my Grandma Ryan who provided some of my most mentally challenging moments. Eager to live near her only child's large family, my grandmother kept a library of books that would have been destroyed in our house. So we'd be invited in pairs to her house nearby to read in her cool, green living room among carefully arranged paperweights and books with glossy colored photos. My favorite of my grandmother's collection, which I read repeatedly, was a Time-Life book on mathematics. It held treasures of drawings, diagrams, and explanations that to my astonishment and delight had nothing to do with multiplication tables.

My father, a chemical engineer, filled our house with science and math gadgets. It, too, had lots of books, but many were dog-eared, missing pages,

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or crayoned. I learned plenty from them; they just lacked the elegance of Grandma Ryan's. Despite the assumption that I would be an elementary teacher like my mother and grandmother, the quest to unlock mathematical secrets ran in my blood, and there was no escaping it. Most of my brothers and sisters, no matter what their college majors, also use mathematics in their jobs.

In school, math was my favorite subject. A girl in the '60s, I had difficulty convincing my teachers to advance me into challenging math courses. So I took calculus for the first time as a freshman in the first class of women at Holy Cross College (Worcester, MA). For me, learning calculus was like riding a bicycle. At first I kept making mistakes and not "getting it"-finally I took off and soared. I loved that course, still have the textbook. I was recently honored to give a mathematics talk at Holy Cross to celebrate the memory of one of my former math professors.

I spent my graduate years at the Mathematics Institute at the University of Warwick (England). To go there, I received a Marshall scholarship, a British government award, which made me feel I'd won a free, three-year European trip. The scholarship was so generous that I managed four years there and finished my Ph.D. I'd chosen Warwick to study a field of math called catastrophe theory. However, once there I preferred classical mathematics such as analysis (more calculus) and topology (the study of points in space and their shapes), and finally wrote my thesis in ergodic theory.

What's ergodic theory? It's an approach to the study of dynamical systems. A dynamical system is any structure that changes. The big ones include the moving stars and planets, and the earth's atmosphere; the small ones include atomic motion or the mutation of genes. One way to study a dynamical system is to write an equation describing the motion of each moving part. This becomes impractical with many-particle systems such as fluids, or those whose size makes it hard to measure. Ergodic theory uses a "big picture" approach: you try to predict what most of the particles will do, but don't worry about the path of any individual object.

In his 1902 Ph.D. thesis, Henri Lebesgue ("luh beg") introduced measure theory, the main tool; it provides a way to measure the size of collections that resist ready measurement by a ruler. However, sets of positive Lebesgue measure do show up on a computer, so they are important to scientists. As a mathematician, I can easily produce examples of Lebesgue measurable sets without any clear length or width.

One goal of my research is to predict the long-term behavior of math models of dynamical systems like weather or waves on the beach. Computers provide a useful tool, but I have to prove every statement before I can publish it as a theorem. Scientists rely on the theory behind computer models of physical systems. One thing I've discovered is that unpredictable behavior is hard wired into many models of complicated systems such as the weather. Unfortunately this means that you gain most information about the system by watching it unfold, and that precise prediction is nearly impossible. In technical terms, we say scientists frequently need math models with positive entropy.

Many mathematicians have influenced my work. John von Neumann, the father of ergodic theory, is known in Washington for his teamwork on the development of the atomic bomb and his contributions to modern computers. But in my circles he's the guy who proved the first rigorous ergodic theorem (Princeton in the '30s). His abstract work in infinite dimensions laid the groundwork for modern ergodic theory, a field rich with physical applications.

Among mathematicians I've known personally, my teacher at Warwick, Dusa McDuff, now a professor at SUNY (Stony Brook), encouraged me the most and she helped me get an excellent professional start. Publishing math research is competitive, and I might have dropped out early except for the advice and encouragement of my mathematical husband, Michael Taylor.

I've been inspired by stories of women mathematicians such as Sonya Kovalevsky, who had to leave Russia in 1869 to study math at a German university. Although at first prevented from earning a degree, she solved the equivalent of four Ph.D. problems anyway. Later she received a degree in part for her work on dynamical systems. She showed, for example, that Saturn's rings cannot be solid (like a wedding band around a marble), but must instead consist of icy cosmic dust.

My job lets me work on mathematics in a stimulating, beautiful, university setting. I still find four-leaf clovers, though my daughter quickly learned my method, and she usually finds them first. Nevertheless, I'm still convinced I'm one of the luckiest people on the planet.