

MR3077156 (Review) 00A09 00A05

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★The joy of x .

A guided tour of math, from one to infinity.

Reprint of the 2012 edition.

Mariner Books, Boston, MA, 2013. xii+316 pp. ISBN 978-0-544-10585-0; 0-544-10585-0

As a second-year graduate student many years ago, I found myself living in a house with a number of fellow students whose idea of dining was fast food every day. Although I knew nothing about cooking at age 22, I bought a *Joy of cooking* text and proceeded to follow its algorithms, and discovered that creating tangible, tasty items wondrously balanced the countless hours of crafting abstract proofs, most of which attempts ended in the trash bin.

Rather than consisting of recipes, *The joy of x* by Steven Strogatz is a series of 30 humorous, succinct, insightful essays, many of which were part of a fifteen-week column for the New York Times, that “give a feeling for what math is all about and why it is so enthralling to those who get it.” It is a book “from an adult perspective” that teaches the reader “everything, starting with $1 + 1 = 2$ and going as far as we can.” Does he succeed in the same way as did, say, Julia Child?

Strogatz writes with a homey style; by book’s end, we know most of his extended family. For example, at age 10, his Uncle Irv challenged Steven with this conundrum: “The cold-water faucet fills a tub in half an hour; the hot-water faucet fills that tub in an hour. Together, how long will it take to fill the tub?” With self-effacing charm, Strogatz admits his original answer of 45 minutes haunted him for years, well into his career as a professor at Cornell. His more mature, alternate solution is an *aha*-moment: “Consider that in one hour the water from the two faucets together would fill three tubs. Thus the two together can fill the tub in 20 minutes!” In another episode, he and his wife gave an invited talk about topology in their daughter’s first-grade class—a hands-on session with Möbius strips. He asked each student “to take a crayon and draw a line all the way around their strips.” When one young man got to the other side of his starting point, he “began melting down. He was on the floor, wailing, inconsolable.” And when they instructed the children to cut their strips along this mid-line, the kids began shouting, “Hey, look what I found!”

In each essay Strogatz brings in familiar culture: a TV show (*Sesame street*), a movie (*My left foot*), a song (Lionel Richie lyrics, “She’s once, twice, three times a lady”), a sports star (Michael Jordan), a movie star (Bruce Willis), an iconic building (NY’s Grand Central Station), a novel (Giordano’s *The solitude of prime numbers*), and so on, so as to illustrate respectively some facet of numeration systems, fractions of fractions, commutativity, velocity and hang-time, logarithms, whispering rooms and conic sections, and the vast distances between primes far out along the number line. Strogatz supports these essays with a 46-page appendix chock-full of links to web pages, papers, books, and thoughts for further study. For example, when reading the first *Joy* essay featuring two muppets, wherein Humphrey is taking a restaurant order from six penguins, and calls out “Fish, fish, fish, fish, fish, fish,” whereupon Ernie suggests using the abbreviation *6 fish*, after which Strogatz juxtaposes the Nobel laureate Eugene Wigner’s 1960 observation about “the unreasonable effectiveness of mathematics” in modelling the real world, and gives a web address to this very readable Communications in Pure and Applied Mathematics article, the reader abruptly realizes that just as Narnia’s Aslan is not a tame lion, neither is this book tame. In turn, the web is a

double-edged sword, and for *The joy of x*, there are literally hundreds of fairly long web reviews, from which I sample a pertinent quote from a typical reader, Mr. David Dinaburg, who writes metaphorically, “The endnotes [of *The joy of x*] lead you to a sheer cliff, toss you a rope, a compass, and a pocket knife, and ditch you in the middle of the Appalachians.”

That is, there is a dark side to this *Joy*. Math is hard. Strogatz admits this, and, for example, calls mathematical expressions, such as the quadratic formula, “porcupines of symbols.” He calls his first encounters with vector calculus and Maxwell’s equations a “mumbled abracadabra.” He portrays the learning of calculus as “requiring a command of geometry, algebra, and various derivative formulas—skills equivalent to fluency in a foreign language and, therefore, stumbling blocks for many students.” When he claims that a typical reader’s favorite math class in high school was geometry—primarily because the subject matter exercises and stretches both sides of the brain, integrating the visual and the abstract—Strogatz is acknowledging C. P. Snow’s dictum about the fragmentation between the humanities and the sciences and their inability/reluctance to communicate with each other. Helping bridge this communication gap was the original motivation for this book. In a book very similar to *Joy*, the physicist Bülent Atalay in *Math and the Mona Lisa* [Smithsonian Books, Washington, DC, 2004; [MR2107362](#)] comments: “In childhood, drafting skills continue to improve until we are around ten years old. But then 95% of the population begins to display regression in their drawing prowess. [p. 152]” Does a similar kind of atrophy occur with respect to mathematical interest and skill? Bülent argues further that Snow’s taxonomy may really have splintered anew, resulting in a third isolated community, the information technology community. The upshot of all this fragmentation is that this twenty-first century of ours both enjoys and suffers from an avalanche of knowledge. Our response of course is both elation and despair.

Most of *Joy* is a celebration, but at times Strogatz cannot help revealing some misgivings about the limitations of what we can know. For example, after a brief foray into conditional probability with applications to the infamous OJ case, he concludes that “the probability that any of this changed your mind about the verdict is zero.” In his essay on the utility of differential equations, and Newton’s successful solution of the two body problem, Strogatz tells the story of Newton “complaining to his friend Edmund Halley that the three body problem had ‘made his head ache, and kept him awake so often, that we would think of it no more.’” After which, Strogatz concludes, “I’m with you there, Sir Isaac.” In a similar vein, Atalay points out [pp. 272–273] that “In the last hours before his death, Leonardo da Vinci, with an air of forlorn resignation, remarked to an assistant, ‘Tell me, did anything get done?’” That is, partial knowledge, incomplete understanding—even for the most brilliant of us—is our lot as humans.

Finally, the subtitle of this book is *A guided tour of math, from one to infinity*. During the 1997 Christmas holidays, I had the privilege of taking my wife and two teenage sons on a safari in the Serengeti during a break in the school year while I taught at the University of Dar es Salaam; our guide never ceased to point out creatures whose presence would otherwise have remained hidden. The yellows, browns, and greens of the grasses well camouflage the yellows and browns of, say, the cheetah. The guide knew where to look; the very arrangement of the herds of zebra and wildebeest oftentimes gives clues to where a predator lurks. So too with Stephen Strogatz. He knows where to look for interesting mathematical objects and structure all around us.

What did he show me? So as not to give away all of his tricks, let me give only two examples. How best can $(-1)(-1) = 1$ be explained? Strogatz gives an animated graph-theoretical metaphor that the enemy of my enemy is my friend, where *enemy*, *friend*, and *of*, respectively, are identified with -1 , 1 , and *multiplication*. Then in a

later essay, he shows that multiplication by the imaginary number i corresponds with a 90° counterclockwise rotation about the origin, which means that multiplying -1 by i^2 rotates -1 to 1 . *Aha!* As a second example, from his essay on group theory in the context of how best to turn one's mattress, I learned how the celebrated physicist Richard Feynman avoided the draft as a young man: when asked to extend his hands, he held out his arms, one palm up and the other down, whereupon the irritated physician said, "No! The other way," and Feynman switched to down and up. Such colorful fun oozes from *The joy of x*. You will enjoy this read.

Andrew James Simoson

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