EDUCATION

Teaching Math to People Who Think They Hate It

A popular Cornell professor tries to help language-arts types learn how to "make math" instead of just studying it.

The author's son and husband take the scalene triangle challenge.

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Math has never been my strong suit. I opted out of it at every turn, particularly in college, where I enrolled in linguistics to fulfill my quantitative reasoning requirement. I even tried to overcome my aversion by taking a second whack at Algebra in my forties, but sadly, I still hand restaurant bills to my husband when it's time to calculate the tip, and have long since given up on helping my teenage son with his Algebra II homework. Despite my negative feelings about math, I am a huge fan of Steven Strogatz, author, columnist, and Professor of Applied Mathematics at Cornell University.

I follow Steve Strogatz on Twitter, and while I don't always understand his tweets ("Would you like Bayesian or frequentist statistics with that?"), I do find them fascinating. When Steve tweeted that he'd be teaching an introductory math course for non-math majors at Cornell University (#old_dog#new_tricks#excited), I emailed and asked him to tell me more. Why would a veteran professor of higher math choose to spend a semester in the company of undergraduates, many of whom would rather visit the dentist than spend two hours a week exploring mathematical concepts?

The short answer is that Strogatz has discovered a certain thrill in rectifying the crimes and misdemeanors of math education. Strogatz asks his students, more than half of them seniors, to provide a "mathematical biography." Their stories reveal unpleasant experiences with math along the way. Rather than question the quality of the teaching they received, they blamed math itself—or worse, their own intelligence or lack of innate talent. Strogatz loves the challenge, "There's something remarkable about working with a group of students who think they hate math or find it boring, and then turning them around, even just a little bit."

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Strogatz believes the key to this turnaround lies not in the material, or the inherent talent of the student, but in changing the way math is taught to liberal arts majors. The curriculum he teaches is called Discovering the Art of Mathematics: Mathematical Inquiry in the Liberal Arts (DAoM); it was developed at Westfield State University by Julian Fleron and three colleagues and funded by a grant by the National Science Foundation. The DAoM approach, which is publicly available through a free collection of books and workshops, is rooted in inquiry-based learning: It focuses on student-led investigations into problems, experiments, and prompts. The typical mathematics for liberal arts class on the other hand, is typically presented in lecture format, usually by non-tenure track instructors, and only serves to further disenfranchise students, Fleron claims.

Twelve years of compulsory education in mathematics leaves us with a populace that is proud to announce they cannot balance their checkbook, when they would never share that they were illiterate. What we are doing—and the *way* we are doing it—results in an enormous sector of the population that hates mathematics. The current system disenfranchises so many students.

Fleron's new vision for liberal arts math aims to intellectually stimulate students, to provide cognitive gains, and get students engaged with math rather than passively listening to a teacher talk about it at the front of a lecture hall. As stated on DAoM's website—"to nurture healthy and informed perceptions of mathematics, mathematical ways of thinking, and the ongoing impact of mathematics not only on STEM fields but also on the liberal arts and humanities."

In an email sent after his first week of class, Strogatz described what this vision looks like when implemented in the university classroom. Using an exercise from the DAoM book *Games and Puzzles*, Strogatz handed each of his students a pair of scissors, as well as a piece of paper with a scalene triangle drawn in the middle of it. (A scalene triangle is one in which all three sides are different lengths.) He then challenged them to cut out the triangle using only a single straight cut. When they looked baffled, Strogatz told them they could fold the paper any way they pleased before cutting it.

Strogatz himself admits that he had trouble the first time he played around with the exercise. At the end of class, Strogatz asked the students if they wanted a hint, but they shouted him down, refusing his help. As Strogatz wrote to me:

> They were having a true mathematical moment. That is, they were deeply engaged with a puzzle that made sense to them, and they were enjoying the struggle. They were feeling what anyone who loves math feels, the pleasure of thinking, the pleasure of wrestling with a problem that fascinates. I told the students to think about the scalene triangle over the weekend and to try it in their dorm room. Over the weekend I started to get emails from some of them, expressing the excitement they felt when they solved it.

The usual arguments against inquiry-based learning, particularly when it comes to math education, is that practice and repeated drilling of basic concepts are necessary for a deep and durable education in math. I asked Strogatz about this tension, and he acknowledged that drilling is important, too. "I want my students to memorize and know basic facts, *and* I want them to understand what those facts mean, why they're important, where they come up in the real world. I want it all and I think students want it all too." He added:

> If we only teach conceptual approaches to math without developing skill at actually solving math problems, students will feel weak. Their mathematical powers will be flimsy. And if they don't memorize anything, if they don't know the basic facts of addition and multiplication or, later, geometry or still later, calculus, it becomes impossible for them to be creative. It's like in music. You need to have technique before you can create a composition of your own. But if all we do is teach technique, no one will want to play music at all.

Strogatz and Fleron both envision a classroom in which math is taught as a both an intellectual discipline and a creative endeavor—where math is *made*, not just discussed. "As with any game, or playing music, or making a piece of art, it's doing the real thing that's inspiring. My students are actually making mathematics—in many cases, for the first time in their lives. And they're loving it. And why wouldn't they? It's a joyous, glorious experience. At every level. Little kids can make math. It may be the mathematical equivalent of finger painting, but it's still math."

Inspired, I challenged my son and husband to create their own scalene triangle origami. An hour later, they were still at it, debating possible folds, trying out multiple solutions, and making math together.