

## **Running the Numbers**

by Jacob Slaughter  
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Professor Rosa Orellana's favorite season to run is in winter. I recognized Prof. Orellana in a Dartmouth College photo when searching for a mathematician to interview, because I have seen her running for years on the road by my house. When I asked her about running, she laughed. A woman had stopped her recently on a run and said that Orellana had inspired her to start running. "You can be a role model even when you don't think you are, just doing something you love," she mused.

In many ways besides running, Orellana is a role model. She is a leading researcher in algebraic combinatorics at the prestigious Dartmouth College in Hanover, New Hampshire. She is the first member of her family to attend college. She is a mother. And she is a mentor who helps inspire the next generation of women in mathematics.

The first time someone told Orellana she was going to be a mathematician was in second grade. She had mastered adding single digits, but had no idea how to do larger sums. She kept getting wrong answers, but this did not deter her. Her teacher told young Rosa that she would be a mathematician someday because she got excited when she did math.

On her first day of high-school geometry, the teacher walked into class, drew a rectangle on the board, and declared it to be a plane. Orellana concluded that a plane was the same as a rectangle. Every question that the teacher asked about planes, she got wrong. On her first quiz, she got a D, but the grade didn't worry her as much as not knowing what she was doing wrong. She ended up getting the highest cumulative grade in the class. The teacher wrote Orellana a letter at the end of the year saying that he sincerely hoped she would study mathematics because of the tenacity with which she approached his geometry problems. This teacher's words reinforced her belief that she was meant to study math.

However, her desire to study math was met by resistance from the administration of her high school. Orellana had difficulty getting enrolled in math courses because the school considered math courses to be difficult. Her academic advisor expected her not to succeed in math. One time, she told her, "Don't come to me crying when you fail." Rosa Orellana did not fail.

Her high school offered little information when the time came to apply for college. Because Orellana was the first college-bound person in her family, her older siblings were also unable to provide any support. She thought that she could simply show up at a local university and register on the first day of classes. Luckily, she learned she needed to apply to college before the deadline at California State University at Los Angeles, and she was admitted. However, Orellana had to work several jobs over the course of college to help pay for her tuition.

In college, Orellana found an environment that was much more supportive of her interests. She was awarded a fellowship and, while searching for a research focus, she discovered papers by mathematician Kenneth Millett of UC Santa Barbara concerning knot theory and its applications to the DNA molecule. Orellana spent the next summer doing research with Millett. He was very impressed by her work, encouraged her to go to graduate school, and even sent her postcards reminding her to apply while he was on sabbatical in France.

After Cal State, Orellana was accepted to graduate school at University of California San Diego, where she earned her master's degree and doctorate. At the time, she was going to study knot theory, but the topologist she wanted to study with was on leave. Orellana's advisor suggested that she take a course in algebraic combinatorics. The rest was history. As Orellana said fondly, "I found my calling."

At Dartmouth, Orellana's research is in algebraic combinatorics. Algebra is made up of sets and operations upon the elements of those sets. She is developing methods to find the coefficients of the product of some functions, called Kronecker coefficients. Orellana recently discovered some symmetric functions. Symmetric polynomials have many applications in physics. While the applications of her work are exciting, Orellana shared that it is the math alone that inspires her. Glowing, she said, "I love the math. I do the math as an artist does art. When I look at the formulas, they look beautiful. When I look at the polynomials and the structures that I am studying, they look so very beautiful."

In addition to her research and teaching, Orellana takes the time to help the next generation of mathematicians find future success, particularly those who belong to underrepresented groups in mathematics. She mentors undergraduate students, graduate students, and postdocs at Dartmouth. She recently served as the research leader for the Mathematical Science Research Institute's Undergraduate Program, which strives to increase the number of minority students pursuing careers in mathematics. She takes on interns from Dartmouth's Women in Science Program and she cofounded the Dartmouth chapter of the Association for Women in Mathematics. Once a year, Orellana leads workshops for local middle- and high-school girls to help them discover the wonder of mathematics that she herself felt at a young age.

Through all her mentoring efforts, Orellana wants to cultivate for young people an environment where they can be free to pursue their passions. "Mentors are important because they open the door to what you could be," Orellana reflected. "You look at yourself sometimes and ask, can I be something more? You look to other people like you for inspiration, and pursue careers that you see those people doing ... There are not enough women in academia to provide that inspiration." Too often, women's career options are not decided by ability but rather influenced by societal pressure.

Orellana's greatest hope is that one day there will be no gender bias in mathematics. Solving the types of problems she studies will require the brightest young minds of the next generation— regardless of gender. "Math will never be easy!" she exclaimed. "I have problems that I work on right now that nobody can solve." Her advice for budding

mathematicians: “Ask a lot of questions. That is how you stumble across something nobody knows. Keep wondering. Read. Play. Discover the future.”

Professor Rosa Orellana loves math, and it shows in her teaching, her research, and her mentorship. She is inspiring the next generation of mathematicians to follow—and perhaps even to run!—in her footsteps.

**About the student:**

Jacob Slaughter is a junior at Thetford Academy in Thetford, VT, where he enjoys studying science, musical theater, Spanish, and Latin. Jacob takes calculus at Dartmouth College. He finds calculus very interesting because of its applications to physics. His favorite pastimes are cross-country skiing, running, and reading. He is the owner of US patents (nos. 9333414 and 972495) for a device that cleans snow from the binding of cross-country ski boots.