

Evelyn Lamb: [00:11](#) Welcome to the Lathisms Podcast. I'm Evelyn Lamb. In each episode, we ask a Hispanic or Latinx mathematician to talk about their journey in mathematics. Today, I'm very pleased to welcome Santiago Schnell. Hi, how are you?

Santiago S.: [00:24](#) Doing fine. Thank you for the invitation.

Evelyn Lamb: [00:28](#) So can you tell us a little bit about yourself?

Santiago S.: [00:30](#) Well, I grew up in Caracas, Venezuela from two foreign parents ... so a German-Swiss dad who grew up literally in Venezuela and then a Spaniard immigrant mother. I did my undergraduate degree in Venezuela, so high school, primary school, elementary school, so all the basics there. I went to an experimental university called Simon Bolivar University, which is very special because regardless of the degree you take, you end up studying advanced engineering mathematics as a minor. And I ended up studying biology because I felt I wanted to go into medical school but, I discovered in the process that I was very good in mathematics, and I knew that beforehand, but I was better than I thought I was.

Evelyn Lamb: [01:23](#) So this school ... You said that you had interest in science already before you went there. So as a child were you interested in math and science?

Santiago S.: [01:34](#) I was. My dad, he was the sort of person who wanted to educate Renaissance children so he exposed his children to absolutely everything. But there was something that he was absolutely certain we'd all oppose, and I was probably the only child who picked it up. He thought that the future belonged to computers and mathematics. And even though he was a professional philosopher and lawyer, he pushed very hard for us to learn how to do computer programming in the '70s when computers were incredibly rare.

Santiago S.: [02:13](#) And I end up taking classes when I was doing my elementary and middle school, very basic classes on computer programming, because he foresees that somehow computers and mathematics was going to be the future, and he came with very useful tricks. So, for example, every time I was taught something at school that was a very basic arithmetic, he would come with a different algorithm on how to resolve the arithmetic problem. So to some degree I had a philosopher and a lawyer teaching me the future of mathematics by inspiring me and introducing me to things that I think at the time very few people could actually foresee.

- Santiago S.: [02:54](#) So after that there was somebody else who would play a critical role. I have an uncle who got trained as a physicist and he was a computer scientist. At the same time he played a fundamental role on bringing me new mathematical problems. And even though it was more a hobby rather than something I was very passionate about, it got instilled. And the moment I went into university, of course, it became very natural that I wanted to combine all the biomedical training I was receiving with mathematics.
- Evelyn Lamb: [03:28](#) Yes, and that's what you ended up doing, right? You entered college thinking you would go into biology, then found mathematics, but you've managed to combine both of those in your career.
- Santiago S.: [03:38](#) Yes, I did. So the way at least Venezuela works is we have a long-term undergraduate degrees, which are more equivalent to advanced master's degrees. So I end up pursuing the degree for five years; the last year is a full-time research internship that needs to end up with a research thesis. And because I already had experience in the laboratory, and I felt that the experience in the laboratory was incredibly frustrating, I decided to make a shift into theoretical biology. And the only way I could make that at the time in Venezuela was moving to a lab of a theoretical and computation physicist.
- Santiago S.: [04:22](#) So I end up going to work with Claudio Mendoza, who, in fact, played a critical role in the transition because he taught me how to be a theoretical and a computational scientist.
- Evelyn Lamb: [04:34](#) And can you tell us about some of the work you did, either as a student or now in your career?
- Santiago S.: [04:40](#) Surprisingly ... and this is something that is very exciting ... So very few people have had the opportunity of doing what I have done so far. So what I started to do as an undergraduate student is what I continue to be doing as an established scientist. I initiated my research extolling enzyme catalyzed reactions. I modeled the rates of how biochemical reactions occur in enzyme catalyzed reactions. And I have been doing that since I was an undergraduate. I have worked on other topics, but the primary subject of my research and the interest, and the things that I dream when I'm in bed, they're enzyme catalyzed reactions and how to describe them mathematically.
- Santiago S.: [05:22](#) And we're interested in two fundamental problems: one is how you take the biochemical reaction as it's understood in the

laboratory and describe that reaction into mathematical terms so that we can follow the dynamics, but the second topic that we're interested in is on the inverse problem. So if I have the dynamics of a biochemical reaction can I determine the kinetic parameters of the reaction using a mathematical expression that allows me to determine the kinetic parameters?

Santiago S.: [06:00](#)

And I have been dedicating my academic career on understanding how we can accomplish the convergence between the forward problem and inverse problem in some kinetics.

Evelyn Lamb: [06:10](#)

I imagine enzyme catalyzed reactions must take place in all sorts of biological systems, right?

Santiago S.: [06:17](#)

Oh they do. So in life everything boils down to enzyme kinetics because enzymes, what they do is that they accelerate the rates of the reactions. The reaction would occur in the absence of the enzymes but it will take such a long time that life wouldn't be able to exist without them. So life has exploited this, the enzyme catalyzed reactions, that actually accelerate normal reactions that would occur in 20 years; they would make them in a matter of seconds or nanoseconds.

Santiago S.: [06:51](#)

And industry has exploited, as well, enzyme kinetics. So, for example, the way cars operate ... so they have as well enzyme catalyzed reactions of surface that operate and accelerate processes in industry. So the list is extensive.

Evelyn Lamb: [07:07](#)

So backing up in your career a little bit, did you have role models and mentors that helped you find this career path?

Santiago S.: [07:15](#)

Well, I will say that in Venezuela I have my experimental mentor who was Raymundo Villegas, he used to be the Minister of Science in Venezuela, so I was mentored by somebody who was a scientist but at the same time a politician, and you know even though he thought that I was a very fine experimental scientist he immediately realized that my passion wasn't the laboratory but more on the thinking process [inaudible 00:07:49]. He actually helped me to find my way, and he was the person who actually put me in contact with Claudio Mendoza, and Claudio Mendoza who is a well-known physicist in Latin America, so he actually guided me as well through the process.

Santiago S.: [08:06](#)

And surprisingly the other person that I have is... I did my minor in philosophy in Simon Bolivar University, and I had a philosopher professor, Rafael Caldera, who actually taught me

how to be a good scholar, and a good scholar in the sense that you need to read and you need to comprehend the literature better in order to come up with original ideas. He trained me as a young philosopher on the side, but that training that he provided was absolutely critical, and once I left Venezuela and I went to Oxford where I pursued by Ph.D. under the supervision of Philip Maini, so since then Philip has been the person that I consult on absolutely everything. He still now plays a critical role in my career, so if I have a doubt about a challenge that I'm facing academically, scientifically, or even politically within the academic system I go and talk to him and he's a genuinely nice person in spite of being an incredibly famous mathematician.

Evelyn Lamb: [09:15](#)

Well and something several people on the podcast have mentioned is finding mentors and people who can help you in your career who might not come from exactly the same work that you're doing, might be in a different area or even in a different field completely. It sounds like that happened with you.

Santiago S.: [09:33](#)

Yes, it happened with me, and you know the only person who actually has a similar career within my mentors I would say is Philip Maini, even though, so he got trained as a mathematician, he did his Ph.D. in mathematics, so everyone else earlier in my career who helped me to become myself a mathematical scientist were not mathematicians. So you have my dad, who's a philosopher and lawyer, you have Raymundo Villegas, who is a biophysicist physiologist, Claudio Mendoza who's a theoretical physicist, Rafael Caldera who is a philosopher. So all these people played fundamental roles.

Evelyn Lamb: [10:13](#)

So now you work in a lab at the University of Michigan medical school, so you must also work with people coming from different backgrounds, though probably not everybody comes from the math side.

Santiago S.: [10:27](#)

I think very few of them work on the math side. So currently I have five people in my research group, and only one of them has mathematical training, and he's a postdoctoral fellow in the group. The other postdoctoral fellow is a mechanical engineer, and then the rest are students and all of them have biomedical backgrounds, which is very similar to the background that I have.

Santiago S.: [10:54](#)

In terms of collaborators it goes all across the board, so I have multiple collaborative projects, most of them are with people who are either medical doctors or basic scientists in physiology,

biochemistry, or microbiology. And the way we operate is that we try to find a problem where the hypothesis that we are testing experimentally is incredibly difficult to validate solely with experiments, and the mathematical model serves like an older experimental tool that actually helps you to interrogate the hypothesis and the mechanism that you're exploring. And it's very fun because we take the most joy when the mathematical model fails to predict something and the failure is important in the process because it allows to understand the assumptions that the biologists and we have made with the mathematical model are incorrect and also the assumptions that serve as the foundation of the mechanisms that they are trying to explore in the laboratory.

Santiago S.: [11:59](#) So I make my living as a mathematical biologist by exploring failure, and the more failures I have the better our models become in the long term. Because of course once we have a failure, we recognize where the model needs to be modified and the mechanisms need to be improved to continue exploring how the biological and the biomedical process works.

Evelyn Lamb: [12:22](#) And that seems like it transitions well into my next question, saying failure is where you really get the new science. So I'd imagine in any career you do have ups and downs you have challenges that you face, and how have you overcome some of those challenges?

Santiago S.: [12:43](#) There is a point where when the experiment fails, when the mathematical model fails, when you believe that you have a fantastic research problem that you have solved, and you write a scientific paper, and it gets rejected. Early on it's very hurtful, but then you start to realize that the rejection is a very constructive part of the process. Sometimes a rejection says you have to have admit, well, there is a failure in the process. Maybe I didn't communicate well what I wanted to say and the failure was more in my part, I didn't do the communication correctly, but most of the failures that we receive in academia, it comes with a positive feedback. It comes with recommendations where we realize where things were not done correctly, and then you have the opportunity to do corrections and then rebuild yourself. And that's something that I like from the failure in the academic system, so regardless if it's a failure in the science or its a failure in the promotion you were seeking or the prize you wanted to win, there's always something that you receive back on the feedback that allows you to become a better person.

- Santiago S.: [13:50](#) And I think the younger people early on, they get very frustrated and even sad that failure is part of the process. What they don't realize is that failure is part of the process because with failure you become a better scientist. And it takes time. So I don't think there is a secret to understanding how you can overcome failure, other than they can own, counting with the network of mentors will actually help you to understand how you can overcome failure, and that's where when I had my first rejections, I talked to my mentor, I would go there heartbroken and then we would recognize where the opportunities for improvement could be made.
- Evelyn Lamb: [14:36](#) So that community is really important.
- Santiago S.: [14:42](#) The community is important. You have the community of people, so I always say I have all these friendly competitors. They are people that I want them to review my work, or they're working in the field, and we have a very friendly relationship when we go to conferences, we probably don't have a very friendly relationship when it comes into reviewing our own papers. But you know I consider them great friends because I want to make sure my work is evaluated with high set standards before it gets published, and if somebody lets me publish something that is not of good quality I don't consider them a good friend.
- Santiago S.: [15:15](#) And you know there are two kinds of friendships, you have the friendship behind the anonymous reviewer that you expect they are doing a fine job, and then when you receive the feedback, and sometimes it can be very devastating, then you have the internal network that could be previous mentors, current mentors, or even colleagues that you have in the university who actually help you to understand and overcome some of the frustration that comes as a result of this. And having the two networks of the people that you know who are the potential competitors, people who are working in the field who can provide good feedback, and making sure that they make you the favor of evaluating your work in the best way so that we improve science together, and then having this internal network of people that, they're not anonymous, or they're part of your mentorship community and your colleagues is incredibly important, so it's a big family and I like that, so I love that for academia.
- Evelyn Lamb: [16:12](#) And finally do you have any advice for people who are interested in both math and other sciences about how to

combine those and build a successful career combining math with other sciences?

Santiago S.: [16:27](#) You know, I don't think there is a unique pathway, I think that's the first advise that I would say some people have this tendency of believing that there is only one way of doing it. For example, most of the people believe that you should pursue first mathematics and then move into the field. I'm a successful example of someone who didn't originally train as a mathematician, but somehow managed to do the transition, and I can live in the two worlds.

Santiago S.: [16:56](#) I think what is important is understanding the two fields relatively well, so you need to have an intuition of what are the mathematical and computational tools that are required to solve a problem, but at the same time you need to get enough understanding from the field you want to work on, which could be economy, it could be business, it could be physics, it could be engineering, it could be biology. To gain a basic understanding of the critical questions that can be solved with mathematical and computational models. There are many things that in economy, politics, sociology could be answered without mathematical models and it would be a mistake to actually try to do mathematics within those questions. So what you need to do is identify the right set of questions, and you know one way of doing that, at least the way I have done it so far, is if I don't know very much about the topic I make sure to find a collaborator who works on that topic and I get taught by the person, by the one-on-one interaction, and academics is very much like that.

Santiago S.: [18:09](#) So even the Ph.D. degrees, so people have this misconception that when you go to do the Ph.D., you do the coursework and you obtain the Ph.D. The coursework part of the Ph.D. is primarily informative, so the critical part of the Ph.D. and the critical part of any research enterprise is a one-to-one relationship with a mentor, and the mentor generally is a master of something, somebody who knows much more than you on one specific aspect that is going to make a fundamental difference in your research enterprise. And when it comes into the application field you need to find that master, you need to identify who is that person that is going to teach you the art of the critical question that you want to answer in that specific topic, and then you bring the mathematics on board and resolve the problem.

Evelyn Lamb: [19:02](#) Thanks a lot for joining me.

Santiago S.: [19:06](#) Oh it's a pleasure.

Evelyn Lamb: [19:07](#) Thank you for listening to the Lathisms podcast. It's produced by me, Evelyn Lamb, and made possible by a Tensor-SUMMA grant from the Mathematical Association of America. Our music is Volveré by La Floresta. Lathisms is an initiative to celebrate the accomplishments of Hispanic and Latinx mathematicians. It was founded in 2016 by Alexander Diaz-Lopez, Pamela Harris, Alicia Prieto Langarica, and Gabriel Sousa. You can find more information about the project at lathisms.org, that's l-a-t-h-i-s-m-s dot o-r-g. Join us next time to hear from another inspiring mathematician.