Numberphile Podcast Transcript

Episode: Finding a Path - with Tatiana Toro

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Announcement of Professor Toro's appointment

MSRI is renamed SL Math

Professor Toro's University of Washington webpage

Podcast with David Eisenbud - Professor Toro's predecessor

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[Gentle piano intro]

Brady Haran [BH]: Today's guest is the Colombian mathematician Tatiana Toro. Professor Toro is based at the University of Washington but also recently took on the role of Director at the Mathematical Sciences Research Institute in Berkeley California. In fact it's all changed because MSRI has been renamed the Simons Laufer Mathematical Sciences Institute or SL Math for short. So there's a new name to remember. Now a lot of Numberphile videos are filmed at the institute with visiting mathematicians so of course I'm really curious to hear about Professor Toro's plans there. But also I wanted to hear more about her personal journey, and that's where our episode starts today.

[Ascending piano]

Tatiana Toro [TT]: I was born in Bogota, Columbia and that's two thousand six hundred meters above sea level.

BH: High above sea level, okay.

TT: Two thousand six hundred and forty.

BH: Two thousand six hundred and forty up.

TT: Meters above sea level.

BH: Does that make life different in anyway or because you're used to it it's normal.

TT: Because you're used to it, it's normal but for example your lungs are bigger when you are… you grow up at such altitude.

BH: So now that you're close to sea level here does that mean you're like superhuman and you're fitter than most? [chuckles]

TT: No, I've gotten older and I've lived too long [chuckles] at sea level, but before initially yes it made a difference.

BH: Okay. What was your childhood like? What were you like as a little girl?

TT: My opinion was that I was a well-behaved little girl, my teacher's opinion seemed to differ. I was born… I was in a family of… I was the oldest child. I have sibling who's four years younger. My parents were both of them first generation to college. They were both physician. My father had done his PhD after his MD, his PhD in Czechoslovakia between 1958 and 1962, and when he went back to Colombia he was labeled as a

communist. And therefore he was not offered a paying position, actually he was not allowed to work for many years. My parents got married soon after that and they lived in the salary of… as a resident in medicine, which was not very high and that's when I was born.

BH: So your father got bit of a hard time just by coincidence that he went to Czechoslovakia?

TT: Yeah, that's what he got… he got a fellowship to go there and that's where he went.

BH: Did he know he was taking a risk? Did he know when he came back he might get a hard time?

TT: You know, I don't think he understood for how long he would be a hard time. I mean the label stayed for years after until I was maybe a teenager, so I don't think he could have guessed. But in his mind he had a… he had a promise that he was gonna come back to Colombia. That he had compromised with his country and he came back.

BH: So coming back to you, what were you like as a little girl? You obviously had parents who were educated. Were you, you know, would I have guessed you were gonna become a mathematician if I met you as a little girl?

TT: Umm… in Colombia becoming a mathematician was not something that people will think about. I don't think it was an option as a livelihood. My parents wanted me to have a good education. Most of the schools for girls at the time were girl schools and most of them were religious. And so that was not an option for me and there were very few coed schools, and one of them was the French school. So the French government has schools in developing world to guarantee that the kids of diplomats are at the level when they go back to France for study. And so these school offer schooling at very reasonable price for Colombian kids, and so that's where I went. A coed school, French school. And because of the French system [laughs] very original. In first grade I learned set theory and I learned how with manipulatives in the playground and I learned how to count in different bases. And I really loved it and so to learn how to count in bases we had a building that was made out of wood, construction, and then we also had little boxes and we had beans and so that's how we counted and we went from one bases to the other. And I loved it, I mean I really… so if you had seen me playing in math class and actually teaching my classmates how to do math, I think you could have guessed that at least that was clearly what I enjoyed and when you saw me other classes you might have noticed the difference so [chuckles].

BH: So it sounds like you… it was very unusual that, A you went to a coed school and it

was a French school, you were quite unusual amongst your friends, I guess then?

TT: Well I made my friends there, actually I made my friend… my best friend to today, somebody I met [chuckles] in… I don't remember if it was pre-school or first… I think it was in pre-school. And what brought us together is, so we had a uniform. The French school had a uniform. It was a wool gray skirt, a blue sweater and the wool skirts were expensive and you are growing and so our mothers had figured the way to make the skirt last, so you had suspenders. And so we wore suspenders, initially the skirts were a little bit big and then, you know, but we then liked to show that we had suspenders and so we became friends because were were the two kids, the two girls in the school in the class with suspenders. And it was very good, we're still best friends now. [laughs]

BH: You bonded over wearing suspenders to keep your skirts up? [chuckles]

TT: You might think that that's a detail but that's… you know? [laughs]

BH: And you're still friends today?

TT: Yes.

BH: Amazing. Is that friend still in Colombia or is she over here?

TT: Oh, she's in Colombia. She lived sometime in Canada for about seven years, eight years and then she went back to Colombia. And I'll see her next week.

BH: So you had this passion for mathematics early. Were you quite well rounded? Were you into other subjects as well and I know you told me yesterday that you liked football and things like that. Were you like a quite well rounded child or were you very math focused?

TT: I think initially in, you know, elementary school, yes I like other things and I have always liked history. History was the other thing that I paid attention to but in the French system we got tracked very early so roughly at the equivalent of 9th grade I was tracked into the math track and yes I had to do Literature, Philosophy, but most of the time I did math, physics, some chemistry and a little bit of biology. So it was very science oriented and it was mostly math oriented. At the end of high school, I think, half of the hours of the week were math class.

BH: Your parents were very encouraging of this, I assume, because they were quite educated? Or did they want you to do something more practical?

TT: No I think my father would have liked me to be a doctor because he was a doctor, I mean. I was a good student, I think I actually think that in high school they didn't pay

too much attention to what I was doing. My mother, I think, she ended up being a doctor, a physician but I think in some ways she would have liked to be an engineer. So she liked the fact that I did math. I recall very well. So they both had told me they like math and we're having a conversation maybe when I was in 9th, 10th grade, and my parents… I asked a math question and then they told me, you know, actually I don't remember how to do that. It was basic question and my thought was, they used to love math and now they don't remember how to do that, that's so sad, to forget the math you have learned. I hope that never happens to me.

BH: Okay.

TT: You know, it's funny I remember that I think that was maybe the time where I am noticing I said I was gonna become a mathematician.

BH: I don't ever wanna forget the stuff that I love.

TT: Yep!

BH: I read that you participated in the Math Olympiad for Colombia? What was that experience like?

TT: [Laughs] Not like anybody else who you interview will tell you. [Laughs] So this was 1981… it was first time that the Math Olympiad was gonna take place in the United States and the United States decided that they were gonna have a big event. And as such they decided a number of countries that had never been invited, and so Colombia was invited. And they invited Colombia to bring a team of eight kids and it was relatively last minute. Colombia didn't have the infrastructure to do anything, so what they did is a group of mathematicians took over preparing the kids. And so they invited a number of schools from just Bogota at the first Olympiad it was just Bogota. To send four students per school. And I run into the boys who had been selected by the school to go, to this exam. And I asked them, I mean it was a coincidence, I mean they're coming down, I'm coming up the steps. Where are you going? They said, we're going to the Math Olympiad. And I said well what's that? And they said well, there's this thing that's an Olympiad and you go and take tests to see if you make it to the team to go to the States. And I said oh I wanna do that. They said, well the school chose, I'll go talk to the math teacher, I wanted to talk to the math teacher. He told me, look, they asked for four kids, we chose the… the boys in 12th grade because we thought they had a better chance. If there's room in the car you can go but you have to explain when you arrive that you are not coming as part of the school. The school is not endorsing you. We're not sponsoring you as the other guys, and so I found room in the car. I went I explained my situation, I'm here independently, the school is not sponsoring me. They're the ones

sponsored by the school, not me, can I stay? They say I could stay, I managed to classify and I was number five in the team. The team's come order, and the reason it comes order at least at the time, all the people who were number ones took the test together, at the Olympiad. So I was number five.

BH: Yep.

TT: Once I made it the school decided to sponsor me. They were very proud that they had sent me [laugh] to the test. I came to the US, there were somewhere around a hundred and eighty-six kids. There were of those, there were maybe six to eight girls. Some of them came from the Soviet Union, so those teams were quite guarded. I met a number of kids from the French, so I spoke French, I went to a French school, from the French team and French-Canadians and I found out what they were doing at schooling and I thought, oh that's exactly what I'm gonna do. In terms of the Olympiad I did horribly.

BH: Right?

TT: This was… you know, I have never been a fast thinker so and that was required. I was very nervous, but this opened all my horizons. I mean I found out there a path. In Colombia I didn't see a path. I thought that I actually was gonna be a petroleum engineer because that was the closest thing I could imagine to do math and to have a degree of freedom that I wanted.

BH: So the exposure to the children from other education system was very inspiring for you?

TT: Yeah, I mean, they told me… they basically taught me the path after what I was doing in school could be. And I decided then and there that's what I was gonna do. I went back, I took the exams from the French system, I took the baccalauréat, I got the mention that I needed. I applied to schools in France, I was accepted, and I went. [laughs]

BH: So you did your schooling in France then?

TT: No, that will have been too easy. No, I went there for a year. So I'm gonna try to describe the picture. So first of all this is many years ago.

BH: Yeah.

TT: Many many years ago. Colombia was a very closed society especially the State where my father came from. Women never moved out of their parent's house before they were ready to get married. So having an eighteen year old pack her bags and move

to Paris was not well seen. This was not something that a respectable father would have allowed her daughter to do, but I was old enough to not need… you know, I was able to do it. It was very hard. I did not know what jet lag was. I didn't understand that [laughs] there was a time difference in the world and at the time telephone communications were very expensive. In the back of all of this is the fact that at the time my family did not have many financial resources. So we were able to speak on the phone, twice a week for ten minutes each time. And then, given how that I came from a very tight knit family, I was very homesick.

BH: Hmm.

TT: The French environment I… somehow I ended getting… French at the time liked to rank everything. I ended up being in the best school in what was supposed to be the best class with the kids who had done the best in these exams that I had taken and this was not a friendly group of kids. [laughs]

BH: Right.

TT: It was very competitive. There were fifty-five of us when we started.

BH: In Paris this is?

TT: In Paris in the class. Louis-le-grand in le cinquième. Of those fifty-five there were eight girls. By the end of the year there were only five. And I did not return. So, it was very hard. It was a harsh year.

BH: Do you look at it as a positive experience in your life or a negative?

TT: Oh it was a very positive experience in my life. For two reasons… I mean a learned a lot about myself. My performance in class went from fantastic to horrendous and…

BH: Because the material had become harder or because of the other pressures weighing down on you?

TT: Because of the other pressures.

BH: Hm.

TT: Because… the material was hard. The material was hard, *taught at a book by key* *[ed note, the italicized phrase was the only suitable transcription] . Yes, but I love math, so that wasn't the issue. And what was interesting is that in the exam that we took right before we went on vacation, in Christmas when I was gonna see my Aunt and I had the family to look forward to, I did fantastic. And the more depressed I was the worse my

grades were. So it was… it taught me that balance [laughs] in life is important in order to succeed professionally for example. Not only that but it also taught me that maybe I wasn't ready, and financially I was putting a humongous strain on the family, so that is part of why I went back. That emotionally absolutely I was not ready but I that I needed to do everything possible to be ready to leave the next time. I remember landing in Bogota, after a year in Paris and thinking I'm here to stay for a while but I'm leaving again.

BH: It sounds like from meeting those boys on the staircase and talking about the Olympiad to going to Paris so early, despite the stigma, that you had a lot of initiative. You knew what you wanted and you were pushy, you would push for what you wanted?

TT: Mhm. Yes and I think I owe that to my parents. That despite being, you know, they treated me, first of all in my household my parents always taught that education was the key to success because it had been for them. And my grandfather on my father's side was a farm worker. My father was one out of… ten siblings. He was the only one to go to college and ended up becoming an MD PhD and years later in Colombia he, you know, he really was recognized as the only neural-pathologist and he started the branch called tropical neuropathology. And my mother was a pathologist also who was very successful in her branch of pathology so education was the key to success. I learned from my mother's side in particular, from my grandma, maternal grandmother, who was an indigenous woman who never spoke about her life before meeting my grandfather. I think it was a difficult one. I learned determination, I learned the fact that she, my grandmother, from where she stood she fought for my mother and my aunts to be able to attend college and so she showed determination so did my mother and my aunts and so. I'm a product of my family. [laughs]

[gentle piano music]

TT: Can I take you back a tiny bit?

BH: Of course.

TT: Because, so what happened between coming back to Colombia and starting schooling there. So Colombia is a country with lots of history. Things happen in between from the historical perspective that affected my schooling. So I went back, I'm gonna reveal my age, but okay, so be it.

BH: [chuckles]

TT: [laughs]

BH: [laughs]

TT: I went back in June of 1983. I decided to start at the National University, because the year had been hard I actually took the exam to go into medicine. I did there, to the National University, I got in I was number one in the exam and so then I had a fear. I did not wanna be a physician so I petitioned that I be allowed to get… there was no mathematics that semester starting. You could not be Freshman that semester. I petitioned to start physics which was the closet thing. It was incredibly lucky coincidence because as a Freshman in physics you needed to do a lab. So I started in physics and did a lab because the National University had suffered some closures due to political situation, we were not on time. I mean we started somewhere mid-October, beginning of November. I finished the class and then when the second semester, a little bit after, May 16, 1984, there was a very large demonstration at the National University in Bogota, the reason was some students from the National University in Cali had been killed the day before by the army and this demonstration ended up in a fight where the many students were… disappeared [sighs] I mean exactly what I said. There's a… some students died, the university was closed, barbed wire was placed around the university and the university was closed for a year. And so I was not able to study, I was not able to attend classes. Initially the university was basically shut. The buildings were closed, the lights were off. After some time, after a few months from May, they allow faculty back into the building to gather their stuff and so I petitioned that I be allowed to take it to teach myself the classes I was missing. Or to continue the classes I was in. Take exams and if I passed the exam they will count as if I had taken the class. So basically by the time the university reopened, which was in 1985, a year a couple of months afterwards I had basically finished all the math curriculum.

BH: Self taught or were you in communication with lecturers?

TT: No, self taught.

BH: Just from books?

TT: Yeah, sometimes I was able to go and ask questions but not very often. So basically when the semester restarted I was already had finished that class I really… so I was by the time things started I had been registered really for only three semester at the university but to graduate you need to have been registered for four, I was missing a history classes. A humanities class, I took history, so my last semester I only did a history class and I graduated after four semesters of being at the university which is the minimum to allow to graduate from the university.

BH: That's… it sounds like you're a prodigy. Like it's amazing doing it super quick, self taught.

TT: I am determined. And I had had, you know in the French system had taught me a number of things.

BH: Okay. Were you part of those protests by the way, or was that sort of separate from you.

TT: No, I think one of the things that has kept [chuckles] me alive in Colombia is that I have very good survival skills. So here is what happened. That morning I arrived to university and there were pictures of bodies on the ground and all the ways… there were flags everywhere and there was a call to a demonstration. The environment was very tense, I mean you felt the army was already in the neighborhood. I went to class and I thought, I'm getting out of here this is gonna be ugly. My best friend from college said why don't you stay? I wanna stay, I wanna see and she stayed and fortunately she came out alive, but what happened that day and the things she saw marked her life… in many ways. So no… I left.

BH: A crucial decision in your life, perhaps?

TT: Oh yeah. [chuckles]

BH: Yeah. So now you've graduated, this is positive news.

TT: Yeah. [laughs]

BH: Yeah, and what do you do now? You've graduated in mathematics?

TT: Yes, with a BS in math.

BH: Yeah, yeah.

TT: I wanted to go do a PhD in mathematics because that was a way to learn more mathematics. I had some teachers who had done PhDs both in the US and in Germany and they said, yes, you should go. I applied to a number of schools. The number was limited by how much money I had to apply to schools. And I applied to somethings that somebody knew somebody and I thought I will get in and I applied to a couple of for one reason or another I wanted. And I got into Stanford.

BH: That's not trivial. That's like top of the tree, almost, isn't it?

TT: Yeah, it was a very good school.

BH: Yeah.

TT: I had no idea, actually…

BH: Yeah?

TT: I had applied to Stanford because I heard it was close to Berkeley. The truth was I didn't exactly know where Stanford or Berkeley were at the time and because it had a good medical school. Which of course doesn't relate at all to mathematics, but from where I stood that must be a good school. If you have a good medical school you must be good at everything. Remember I look at life from my parents so they were doctors.

BH: Yeah.

TT: I got into Berkeley and into Stanford but Berkeley did not send a financial information at the same time and it was clear that I need financial aid. I mean I needed tuition and support.

BH: Yeah.

TT: And so and Stanford did. So I accepted Stanford right before I got the information from Berkeley and at the time it was very lucky. Stanford was a smaller class. They took good care of the the graduate students and things went well.

BH: So you've had this unusual undergraduate experience where you're sort of self taught, you've done it very quickly. You've done it in another country and now you're at Stanford, one of the great universities of the world. Were you prepared? Once you were dropped in the deep end to do a PhD at this prestigious university, what was it like, that transition?

TT: I think what I knew mathematically was enough to learn what came next but in particular I mean I think… I believe in life is not only what you know but your attitude toward learning what you don't know. The experience in France, the fact that I had to teach myself the undergraduate curriculum in Colombia, gave me a sense that I could do it and also I mean I recall what my brother told me as I'm leaving Colombia to go to the US. He said you know, the last time you left it didn't work, but remember clearly you do not fit here. You need to make this one work. And so, it was true, I had a big motivation. So yes, you know, in grad school you have to work very hard. [chuckles] And I did but I never stopped to think, oh, am I prepared? Well, they were offering what I had to learn so I sat down and learned it.

BH: I imagine in terms of how you were treated as a treat Colombian at Stanford, I imagine at these universities so many people come from so many places that you sort of

were able to fit in?

TT: The PhD program was very international. There were kids from lots of different places. What was surprising is that I had imagined there were not gonna be that many women because there's not that many. [laughs] But my incoming class at Stanford was a little larger than usual. It was seventeen because there were five kids who were coming, somebody who were just moving their to exchange. But I was the only woman of the class.

BH: Right?

TT: And at the time there were very few women in the PhD program at Stanford. On the other hand that meant we were very supportive of each other. So I somehow had this group of women that welcomed me and then the first years we all were exactly in the same boat, that Stanford, all the first years did exactly the same thing at the time. So we studied together. Many of us were foreigners from far away countries so we worked together.

BH: A lot of people I've spoken to for these podcasts when I talk to them about their undergraduate experience as they come towards the end they start developing their own specialization, passions, they might be influenced by certain lecturers to think this is where I want to go. Because you were so self taught during your undergraduate were you able to do that? Did you finish you undergraduate with the particular niches you wanted to move into in the mathematical world?

TT: I thought so. So and it was because there was one book that I had read. No there were two books that were more advanced than the others and I thought I was gonna go that direction and then I took a class on that my first… the fall quarter at Stanford of my first year and very soon after I realize, oh no, that's not it. So I went with a very open mind to the classes that I took. And in the Complex Analysis class I liked the style of… I liked what we were learning and I liked the style of the faculty member. The class was taught by Leon Simon and he became my advisor and my TA was Dan Pollack who became my husband. So, you know, after [laughs] I mean it took some time but [laughs]

BH: Complex Analysis was good to you?

TT: It was an excellent class, yes. [laughs]

BH: And so I mean I won't go into the details of the mathematics partly because this is a podcast and partly because I wouldn't possibly understand. But just for people listening what became your specialization. Just complex analysis, anything else?

TT: No actually it was not complex analysis.

BH: No?

TT: What became my specialization is called Geometric Measure Theory, and I'm gonna give you an example. This is not gonna sound like mathematics for a second but just bear with me. I'm actually gonna give you two examples. First imagine take a wire. You take a wire you bend it however you want, you make a soapy solution and you put it and you come out and there is soap film attached to your wire and so geometric measure theory is the field in mathematics that gives theoretical explanation of what this soap film that helps you predict how smooth it is. I mean I'm sure you have a picture of a soap film in your head, where you see very smooth pieces that come and intersect other pieces in specific ways. So Geometric Measure Theory tells you that this thing exists and helps you study the way they intersect.

BH: Okay.

TT: The other thing that I did later but is also Geometric Measure Theory. Imagine you are driving and it's snowing and so the snowflakes are falling on your windshield and you see very well the very raggedy edge of the snowflake and that snowflake has some properties from the mathematical point of view, although you might think, [laughs] why would someone wonder about this, you wonder if you can make a snowball whose surface has the same raggedy properties because you think of a snowball it tends to be rather smooth, but no, the snowflake on your windshield is very raggedy, so that's something we answer with a collaborator years after my PhD but…

BH: Do you deal with such beautiful looking objects or do you turn it all into formulas and mathematics if I lookout one of your papers.

TT: Um… formulas are beautiful. So [laughs]

BH: Sorry! Of course they are. They are!

TT: [laughs]

BH: But they take special eyes to see the beauty.

TT: Correct. No, I have never drawn the beautiful pictures, some of them are difficult but they are always in my mind.

BH: Okay. So you finish your PhD.

TT: Mhm.

BH: Presumably… [laughs]

TT: [laughs] I did.

BH: And what happens next? 'Cause I know this can become one of the things of academia in general, the PostDoc trap and tryna find where to go next. What do you do next?

TT: So lemme again. Clearly it's not that I only like history, but history has had a context. So let me give you the context under which I graduated. Right before I graduated, within a couple of years of graduation two things have happened. There was Tiananmen Square and the Berlin Wall fell. And let me explain what that meant from at least at the very local, my local environment from the job point of view.

BH: Hm.

TT: So after Tiananmen Square, Chinese students who until then had come mostly to the US on a J1 Visa and had to go back to China afterwards, I don't know exactly, parenthesis I'm not exactly sure, they all came on a J1 visa but they had to go back to China before they were able to apply for the job. The government of the United States, well it's unsafe, you can stay. So suddenly there were a larger number of Chinese students applying for jobs and in the area, so the area I study is related to Chern's work. Chern big, one of the founding fathers of MSRI.

BH: So you're looking for a job in an area that is popular with Chinese students and graduates.

TT: Some of them.

BH: Hm.

TT: And moreover the Wall had fallen. So suddenly many mathematicians, who were already established mathematicians in the Soviet Union were applying to come to the US and they were willing to take beginning jobs.

BH: Really competitive job market all of sudden.

TT: And because the Wall had fallen, some sources of funding for mathematics, for example DoD, the Department of Defense, they were withdrawing their support because there was no need anymore. And so it was a very very competitive job market. Many of the people who graduated from Stanford with me and then people started

getting one job, one year at a time, they ended up leaving. And I had let's call an additional perk. It's called a two-body problem, so my partner at the time, my husband later on, was also a mathematician and who graduated a year prior to me so our goal was to get the best possible post-docs we could and then try to figure out a way to get jobs in the same place.

BH: I've never heard that term for that, two-body problem.

TT: Oh.

BH: Because so many mathematicians are married.

TT: Oooooh. [laughs]

BH: You know, you gotta find a job together somehow, like, yeah yeah.

TT: It's interesting that, it's a very common term for people in this situation.

BH: Yeah

TT: And so I had a very nice result for my thesis. Something that caught many people by surprise. And so I was very lucky I have a number of options and so I was able to choose what I wanted to do. My first… I spent my first after PhD at the Institute for Advanced Study and then I had a two year postdoc at here at the University of California in Berkeley.

BH: You're ticking off all the great places to work, aren't you. [laughs]

TT: [chuckles] And, yeah. I was lucky.

BH: Yeah.

TT: Luck counts for a lot in life. Then we came here, I came for the year in Berkeley. It was very lucky, my husband, there was a program at MSRI that year in his field so he was here at MSRI. After that we decided to apply for jobs together because it was clear that the job market was gonna be difficult. The people advising us said look you can do a few applications now. We both had an extra year. You can do a few applications now and see what happens. We actually a couple of jobs and ended up taking… made an arrangement with two universities. We went to the University of Chicago for two years because I was very interested in working with somebody there. Carlos Kenig. And then those positions were not likely to become tenured and it was a difficult market. We also talked to the University of Washington. They offered us two position and they were willing to wait two years for us to show up. And so we took the two years at the

University of Chicago and then we moved to the University of Washington where I have been since.

BH: Ever since.

[gentle piano stinger]

BH: Lots of people listening will know what MSRI is and now the name change SLMath. How do you describe what it is? Like if you met someone at a party who wasn't mathematician and they ask, oh I hear you're the director at this building up on the hill there. How do you describe what the institute is to them?

TT: So I always say, I start by saying, that it's a math institute with a broad portfolio. So where we bring researchers at the top of their field to investigate the most pressing questions in their area. That we have an advisory committee that helps us select the programs and pair them, because we want to create new ideas. And that we bring the people together, we offer them a good collaborative space, cross the fingers, and hope for the best.

BH: Throw all the ingredients in the pot and see what comes out.

TT : And make sure that the conditions are optimal and then let the magic happen, okay? But I also emphasize that that's not the only thing that we do. That we have a number of… that we care about making sure that the mathematical sciences are healthy not only now but for the future. And so developing talent from very early stages to later on is something we pay lots of attention. So we have a number of programs of the public understanding of mathematics and we have programs that have been born… one of the important things that I emphasize is that we listen to the mathematical community. And so many of the programs we have, MSRI… the summer research in mathematics. And I've joined and I will be able to, you know, we'll see where we go with each of them. These were born in response to communities request, conversation and they are some of our greatest programs because the community will tell us, look, if you want to guarantee the good health of mathematics in the years to come you need to make sure that you bring young kids from all ways of life with a variety of experiences so that's… we've respond to that.

BH: Is it too early to ask you if you have any ambition or desire or things you particularly want to do? Any way you wanna leave your mark during your tenure as director. Something you wanna accomplish that hasn't been accomplished here yet?

TT: Let me try to answer that question. So we very often talk in this country about the pipeline. The leaky pipeline, who continues to do mathematics and go into the

mathematical sciences and one of the things I see in you know, as you think more and more about the issues you see more clearly but, one of the impressions I've always had is we say, oh the pipeline is leaky at this point or at this point and people run a program a here but then they don't have control of what happens at the two ends of the piece of the pipe that they're looking…

BH: Hmm.

TT: And one of the things that's unique about SLMath, is that we can, at this point, we have built a number of pieces of the pipeline, so we have our Mathical Books, that we distribute to Title One schools in different areas of the US. We are creating guidebooks for the teachers to use this and develop a love of mathematics in kids. So this spans preschool to grade twelve. We have some programs aimed at older undergrads. Some at graduate students and then further. And so what I see one of the things that I would like to do is to build the pieces of the pipeline that we are missing.

BH: Right.

TT: To at least guarantee that we can make a small contribution to that pipeline but by taking care of people from the beginning to the point where they are… they can come out successfully at the other end.

BH: Has it gotten to a point yet where you're starting to see some of the leaks? You've been… I know you've only sort of just taken over but you've been around for a while and having a look.

TT: Oh, we see the leaks and one of my big concerns something that I was concerned even before I got here, and you know, I was involved with MSRI through the scientific advisory committee and the committee on women before, so the sorts of leak that we are paying attention a lot in this moment which is very temporal but is what was the effect of Covid on the young people, in particular we are looking at the statistics are the women leaving the profession. So are the young women leaving the profession.

BH: Because of Covid?

TT: Well we don't know if it's because of Covid but for example we were talking to the AWM because we noticed decrease in some of… in applications to some, by women, and we actually talked to the AWM to see if they had noticed this decrease and they had.

BH: Right?

TT: And so one of the questions were asking right now is was it last year only because

we were just coming out of Covid and there was lots of uncertainty about what the summer of 2022 or the year was gonna look like and that's why people didn't apply or is it because these women who were in academia decided to maybe look for a different option. And so we don't know.

BH: I imagine for many years increasing participation of women in mathematics has been a battle and has been slowly increasing. There's been a dip now has there?

TT: Yes.

BH: Right.

TT: And but we don't know, you know, sometimes you have a year that is a fluke and then it might be that next year that we have an increase and people are really eager to do it, or not, so… and you know there are other leaks. And you know, the leaky pipeline is an overly used… overly used word or expression.

BH: Right.

TT: And we all have an image of what it is. But that is a very concrete example of something that we're trying to understand. What's happening? And it happened not only to women, actually. The young people. One of the things we look at is that at least the anecdotal evidence indicates that a number of people stepped out of academia.

BH: When I think of the institute I so often think of the premier best mathematicians working on the best problems. Like, you know, this is like the Super Bowl.

TT: Mhm.

BH: But you also are thinking of the institute very much in its role of bringing through all mathematicians from kids and high school, university, into the field as well.

TT: You know you did the analogy of the Super Bowl. When you see a kindergartener running in the playground, you have no idea if that kindergartner's gonna be Tom Brady or not.

BH: Yeah.

TT: So if you don't [laughs] if not everybody has the chance to run and throw the ball, you'll never know, who is gonna be your star.

BH: How much do you think your experiences as a youngster, that coming here for that Math Olympiad and getting that exposure was such a game changer for you, informs

you know, do you often think back to yourself as a youngster when you're thinking about the programs and things you're involved with now.

TT: Not necessarily of the Math Olympiad, what I think a lot about is… and it's not just at the institute but in all ways of life, is that I have had a path that can be seen as slightly unusual and I was given chances at the right times. And I think, you know, by a number of metrics I could be considered a success. So I believe that there are many paths that lead to success and that each individual writes that path and that path is not necessarily a straight path, I have taken some detours, personally. You know, life happens. But there are many paths to success. And so when I look at the institute that's what I want to focus on. On the fact that there are many many ways, many paths to succeed.

[Gentle Piano stinger]

BH: You're an administrator now. You know, I see you sitting here talking about things like is the WiFi working.

TT: [laughs]

BH: Is the electricity gonna work. You have to, you know, you're a manager of people now. But you're also a mathematician. You know, you've written papers and you like discoveries. How do you feel about doing this job as opposed to this life long job you've had of just, you know, doing math and, you know, being creative and writing papers and making discoveries? It feels like you're having to put that on the back burner or can you keep doing the math at the same time?

TT: Oh you asked lots of questions, there in one question. [laughs]

BH: [laughs] Well it might be my last question so I thought I'd get a lot in. [laughs] You know what I'm saying.

TT: Yes. So I think change in life is good. I know somebody who once told me, I reinvent myself every seven years, so I haven't done it as often, but I think change is good, it invigorates you. I am lucky that I have built a structure in terms of collaborators that allows me to continue to do math even if I have way less time. So that part is important. And I have a number of junior collaborators who I work with. So there were two things about the job here, managing is one, leading is another. And they're different jobs. And I approach research with curiosity and I approach these two jobs with curiosity. And so management is interesting to meet people. To listen to people, and to learn from them. So maybe I bring the same curiosity to math research to this job, and I look forward, at my professional life and I think I have been contributing through

my theorems and through my mentoring of students and postdocs, and I see this opportunity as a unique opportunity to [music fades in] contribute in a larger way. And so it's good to change.

[music continues]

BH: Well that's all for today. Our thanks to Professor Toro. There are more links and information in the notes for this episode, including information about SLMath. I'm Brady Haran, you've been listening to the Numberphile podcast. And we have more episodes coming soon, so please subscribe, follow and keep an ear out for us.

[Music fades up and out]