Evelyn Lamb: Hello and welcome to the Lathisms podcast. I'm your host Evelyn Lamb. In each episode we ask a Hispanic or Latinx mathematician to talk about their journey in mathematics. Today I'm very happy to welcome Carlos Castillo-Chavez to the show. Hi. Can you tell us a little bit about yourself?

Carlos Castillo-Chavez: My name is Carlos Castillo Chavez. I'm a professor, a regents professor, at Arizona State University, and my field is the applications of mathematics to the life and social sciences. I'm an immigrant. I immigrated to the United States 44 years ago and worked in a factory, and then I went to college.

EL: And what were your early experiences with mathematics?

CCC: I was always good at mathematics in grade school and middle school and high school. I was a good student through, probably through ninth grade. Then it came to 1968 and there was a big demonstration in the country asking for democracy in Mexico. That was before the Olympic Games, and then everybody became very active and in 1968. On October 2nd the government massacred many students in what is called the Tlatelolco Square. There is a book by a famous Mexican journalist Elena Poniatowska that talks about the night of Tlatelolco. After that I became more interested in theater, community theater, to try to make people reflect on the situation of the country.

EL: And what inspired you to become a mathematician?

CCC: Well, I was always good at math. It was never clear what I wanted to know. My father was in love with physics, and he wanted to encourage me to do physics, but I really didn't want to do physics, although I learned a good amount of physics. I was more interested in literature and theater. I immigrated to the United States in 1974, and I worked for a while, and then I went as an undergraduate to the University of Wisconsin-Stevens Point. I started a degree as an undergraduate, and in order to complete my basic requirements, I took a lot of mathematics. I was good at that, completed a little bit more than a minor, and then the faculty at Stevens Point encouraged me to pursue a career as a mathematician, while the people in literature were enthusiastic but not as enthusiastic, so that made my choice.

EL: Okay. So you didn't enter college knowing that you wanted to do math.

CCC: Even up to this point—I've been eighteen years a professor at Cornell University in seven different areas, a professor of seven different areas at Arizona State University in the School of Human Evolution and Social Change, School of Sustainability, with several other appointments, directed a Center in Applied Mathematics—and I'm not quite sure still what I want to do. And I'm being serious here. I like science. I like the applications of mathematics, but pretty soon as a postdoc I I got involved for the first time in biology since 9th grade, and then I became in love with evolutionary biology. And at this time I'm very interested in the role of human behavior and social dynamics on the spread of infectious diseases and the evolution of infectious diseases. So it's very hard to pin me down exactly as to what I, but mathematics has been a fundamental tool in my research and in the promotion of under represented minorities. I have had my own high school program. I have my own undergrad program, and I have my PhD program. They are devoted to the application of mathematics to the life and social sciences. I'm the founding person of these programs, and it has inspired many young minorities and non-minorities to become mathematicians through the applications in the life and social sciences.

EL: And that kind of leads naturally into my next question, which is about mentoring. Early in your career and when you were in school, did you have mentors and people that you looked up to in mathematics?

CCC: I have always had many, many mentors. As an undergraduate at the University of Wisconsin-Stevens Point, the math community were very interested in my development. As a graduate student, I I applied to various schools but only one accepted me, the University of Wisconsin-Milwaukee, so I went to the University of Wisconsin-Milwaukee, where I suddenly became a very good student, interested primarily in pure mathematics, in the work of Polish mathematicians that were the leading mathematicians prior to the Second World War, and that includes Sierpinski and many others that were involved particularly in what is called naive set theory.

So I decided I was going to do my research on that, and when I was about to defend my PhD proposal, I had an incident with my then-advisor, who asked me to go out to dinner with a group of people that he knew: an Asian-American professor, and there were three Anglo professors, including the distinguished guest and myself, and all the night they talked. I listened, and towards the end of the dinner my then-PhD advisor said, “Have you noticed the memo that has been circulating around?” This must have been around 1979 or something like that. And the other professors seemed unaware, and then he finally clarified: “Yes, this is a memo that says that we have to help(—at that time we were called Hispanics; you know that changes every year) and blacks (I think that's the way African Americans were referred to then) and Native Americans (I don’t think that was the word then)” And everybody was, well they couldn't understand why he brought up. And then he said, “Do you notice that they don't mention Asian Americans?” And nobody said anything, and he said, “The reason they don't mention Asian Americans is because they don't need any help. They can do things on their own.” So that was my PhD advisor. I was devastated about that. I had been in high school very active in the 1968 movement. I had protested the government. There were armies on the streets, and you know, perhaps not very wisely we risked ourselves unnecessarily, and here I stood silent. It was the end of the dinner. The other professor seems to be quite upset. I left in tears, and the next day I went to university and I said, “I want a new advisor.” And at that time changing advisor was not easy, so he said that first I had to take my Ph.D. exam, and then if I passed it, then I would get a new advisor. And the other professors complained. They said, “Carlos is a really good student,” et cetera, but that was never accepted, and so I quit. I went to work at a bank and other places, but many of the people, particularly the professor Gilbert Walter the University of Wisconsin-Milwaukee, they never let me out of their sight, and they insisted that I should go to graduate school. So eventually I applied to the University of Wisconsin-Madison and many other campuses, and this time I had excellent grades, I had excellent letters, and pretty much every school that I applied to offered me support. But I always wanted to go to the University of Wisconsin-Madison. I go to Madison, and I eventually decided that I was going to do some sort of applied math. I met my advisor Fred Brauer. I never took a class with him, I never heard him speak, but I liked him, and I start talking to him, and he gave me a problem, and three months later I have some solutions. He told me, “You have a PhD thesis.” He realized later on that I was in my second year there, that I had not taken my exams, that I had not done anything that you are supposed to do before to prove that you can do research, but I had a PhD thesis already. So I finished my PhD thesis before I finished all the requirements for the PhD.

EL: Unconventional.
CCC: Very unconventional.

EL: And do you have any advice about overcoming obstacles and challenges in research?

CCC: I have had an extraordinary career as a mentor. There is something called the math genealogy project, and the math genealogy project—PhD students essentially go and put their names, their thesis, and who was their Ph.D. advisor. So I put my name there my PhD adviser was Fred Brauer, and then you click on Fred Brauer, and you see who was the PhD advisor of Fred Brauer, and he was a guy called Levinson at MIT, and you go on and on. So you have a genealogy of people and who had been their mentors and their mentors' mentors, and so forth. In that list they also have what they call extrema, so they have the people, the top 250 mentors in the history of mathematics. I said most of the Ph.D.s in mathematics never have a Ph.D. student, so then some of them, they have one, two, and so forth. And then they have a list of who has had direct descendants, which is the Ph.D. students, the top 250, and I have now 48. In the list there appear 47 but it doesn't yet because there's a problem with updating one, but I have had 48, but that put me among the top 200 Ph.D. mentors in the history of mathematics. And in my case, I have had 26 U.S. underrepresented minorities as my Ph.D. students, more than anybody in the history of the United States, including 22 Latinos, and I have the most U.S. Latino Ph.D.s in the history of mathematics. I had also students from Latin America, which is not the same thing. I have had about seven students from Latin America. 40% of my students have been women. So I'm very familiar with mentoring.

What I've found that was critical for mentoring: number one, to attract the students to mathematics. What is the best way to attract the students into mathematics? And then identifying that passion and then helping them develop in that direction. So in 1996, I established what is called as the Mathematical and Theoretical Biology Institute, and this institute has mentored close to 500 students. And these students come to the summer program for eight weeks, and then many of them come two times three times, and then many of them come as mentors, and some faculty that are in love with the program have worked at this program for 22 out of the 23 years or something like that, the same faculty. And the rules of the game are different. The students have to they work in groups. The first three weeks we train them so that they speak the same language. There are students from biology, from physics, from mathematics, mostly from math, but they are from other fields, and then they they select a question. But typically in mathematics, the faculty have a list of questions and ask the students to choose. So these are questions where the mat faculty has some idea what to do, some very good idea what to do. But we don't do that. We ask them to formulate a scientific question, and then we work with them to produce a 30 to 50 page manuscript that eventually gets published. What happens when we do that is the ownership of the project is of the student, not of the faculty and because the ownership of the project is of the student, not of the faculty, then they are very passionate about that and very dedicated. Furthermore, most of the time we the faculty know nothing about the project, so that demystifies the idea that mathematicians on faculty are geniuses. We are not. We're not even close. And so they realize that, "Oh, I am smarter or as smart as my advisor. As soon as we talk about something that he or she's not familiar with, it turns out to be that I have better ideas and he or she does." This is very healthy

Now what are the projects that the students have chosen? The projects students have have chosen are, for example: what is the impact of gang dynamics, like Mara Salvatrucha and things like that, or what is the problem with the, what is the impact of the three strikes law in California? Or what is the role of recidivism in prisons? Or Ebola? the first real project on Ebola came out of this program in 1996, a second in 1999 that resulted in a publication in 2004 that everybody cites because it's the first publication to quantify Ebola, and these were students of African descent that worked on that. We have had around 500 participants, close to 350 or more in graduate school, 152 have finished their Ph.D.s. 90 of them are underrepresented minorities, which means in the last ten years there has been an average of eight under represented minorities getting a Ph.D. in some areas of mathematics that came through the program, which is the largest contribution by any party. Considering that there are about 20 U.S. Latinos getting a Ph.D. every year, we through our program come about 40% of them every year. The most interesting thing about them are deliberately selected from non-selective schools. I went to a non-selective school, University of Wisconsin-Stevens Point. If I had gone it to a major school, probably I would have not made it for many reasons, but that was a very good school for me. And what I have done over the last 20-plus years is to take student from non-selective schools, get them through my summer program, and then help them follow their career dreams, and then out of that we have been able to show that the school of origin is irrelevant if you provide enough support for several summers and if you discover what is their passion and support them to get some results in things that they are passionate about. So many of the students that have come here have gone into applied mathematics of different kinds, and some of them have gone into pure mathematics. Most of them want to do something that is useful, and often as undergraduates, they think that mathematics is not going to help them give back to their communities, and through this program they learn that in fact that's not the case.

EL: So are there any last comments you'd like to make, any advice you have for students who are interested in math, anything like that?

CCC: Well I I think one of them biggest challenges that I have seen, and this has to be mostly for mentors, is that you identify a talented math student in one of your classes, and this, this person is very talented, and then trying to encourage them to do math, it's not enough to tell them that they are talented and that they can do math. One has to figure out, you know, what are their interests? It has to become a little bit of a personal enterprise, and then trying to figure out a way to show them how mathematics is being used to address problems of global warming or climate change in general, issues of sustainability and how with a bachelor's degree in mathematics you can go and get a Ph.D. not only in mathematics or applied mathematics but you can go and do it almost in any area that you want, from statistics to the environmental sciences to sustainability to public health because people with quantitative training essentially happy door open to almost any field of study in science, technology, and engineering that they want. So we we don't want to lose these talented students just because they think that mathematics is unidimensional. There should be many branches, many dimensions, because eventually some of the students that go into mathematics because they are interested in issues of sustainability might turn around and become the best mathematicians in the world.

EL: Thanks a lot for taking the time to talk with me. I feel like I could keep talking with you for another hour, but this is probably a good place to end.

CCC: Thank you very much.

EL: 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 Gabrielle Sosa. 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.