

**Sue Nelson**

Hello, and welcome to the Create the Future podcast brought to you by the Queen Elizabeth Prize for Engineering.

[Music]

There aren't many 15-year olds with a Wikipedia entry, but Gitanjali Rao in the United States is one of them. In it, she's described as an inventor, an engineer, a scientist, TED speaker, author and STEM promoter. It is a pretty impressive list of descriptions for someone who hasn't even left school yet. But then Gitanjali already has an impressive list of achievements to her name. She won the Discovery Education 3M Young Scientist Challenge in 2017. She's been recognised by Forbes 30 under 30, for her innovations, and last year, she was named TIME Magazine's first 'Kid of the Year'. Now, if you think that's impressive, wait until you hear this interview. She's amazing. My first question to her though, was, when did she first realise that she really loved science and engineering?

**Gitanjali Rao**

The biggest moment when I realised my passion for science and engineering was actually when I was about four or five years old, there was never really one aha moment. But everything started to basically make its first steps like take its first steps into the world of science. My uncle got me this science kit which I used every single day. But soon, I started combining not only, you know, just doing the experiments in the kit, but combining the concepts that I used in it for kindness, to create positive change in the world. And that's exactly where I am today.

**Sue Nelson**

Did you really have such a sort of altruistic approach so early on? Or was it because it was intellectually stimulating, and then the applications came later?

**Gitanjali Rao**

It was a combination of both actually, it was always intuitive, this idea of, you know, putting a smile on someone's face, you're making positive change. But also, I was able to see the applications of science in the real world, which made me want to do it even more.

**Sue Nelson**

Now, all your parents at all involved in any STEM field?

**Gitanjali Rao**

My parents are both actually in the technology field. So, they both work in business and information technology. So, it is a field of STEM, but definitely not exactly what I'm working on.

**Sue Nelson**

Would you say that your parents have been a role model for you?

**Gitanjali Rao**

My parents have absolutely been one of my biggest role models since day one. Since they've allowed me to really explore my passions beyond what was given front of me.

**Sue Nelson**

You developed a device when you were just 12 years old, called Tethys. Now explain how this came about? Because it's pretty interesting because it involved a major scandal.

**Gitanjali Rao**

Yeah. So, with Tethys I heard about the water crisis in Flint, Michigan in the US about five or six years ago, and it was just so appalling to see how many kids my age were drinking a poison every single day. And I actually went about looking for ways to solve that. And my approach for that was creating some sort of lead detection tool to do it.

**Sue Nelson**

Now, this lead detection tool was necessary because effectively, Flint's water supply had been contaminated with lead from old water pipes, where did you get the idea for a device?

**Gitanjali Rao**

I always look for ways to solve problems using science and technology. And I used that knowledge that I knew about 3D printing and, you know, creating apps and carbon nanotube sensors and put together a device to help people, but at the same time, I spread awareness on these problems that I'm solving. Um, I like to say that both science and awareness go hand in hand. Basically, Tethys is able to detect a lead in drinking water faster and more inexpensive than current tools. And it's built on something called carbon nanotube sensor technology, which is specially embedded with chloride ions. So, when it is dipped into water containing lead in the water binds to the chloride ions and forms these lead chloride molecules, which then essentially causes a change to the flow of current. So, let's say you were driving over speed bumps. So, the more speed bumps there are, the slower the car is going to go. Similarly, the more chloride ions that are at the base of the nanotube, the slower that the resistance is going to go. And then all the results are sent out into your mobile phone on an app that I created.

**Sue Nelson**

And so, you then use the app to get a sort of lead quality reading on the water.

**Gitanjali Rao**

Exactly. So, the app is able to tell you a directional result, which shows you if it's slightly contaminated or critical, for lead status.

**Sue Nelson**

Now, I can't imagine you learned about carbon nanotubes at school. I mean, maybe you do and I'm just completely out of date in terms of the syllabus now. But where did you find out about the properties of carbon nanotubes that made you sort of put two and two together?

**Gitanjali Rao**

So, I didn't learn anything about carbon nanotubes at school, I basically knew the bare minimum of what carbon was. And I really took it upon myself to research something like that. So, I took online courses read a lot to figure out really what the in depth of nanotubes were and how they could apply in the real world.

**Sue Nelson**

And it was from MIT, was it, an MIT website that you first learned about this?

**Gitanjali Rao**

Yeah, so it was from MIT's Technology Review, where I originally learned about carbon nanotubes, and I continued to grow my, I guess, knowledge upwards from there, but they were using these nanotube sensors to help detect hazardous gases in the air.

**Sue Nelson**

This device led to you winning the discovery, young scientists challenge. And I was quite astonished when I saw the amount of the award because it's \$25,000. Now that's a huge amount of money. What did you do with it?

**Gitanjali Rao**

It is a huge amount of money, but most of it is invested back into my work, which I'm still working on investing the full amount. And apart from that, it's also put into other charities and organisations that I work with. And lastly, stored into my college funds as well.

**Sue Nelson**

Perfect, because you, you also got an additional amount of that didn't use sort of the same amount again.

**Gitanjali Rao**

Yeah, there were quite a few times actually. I was in the maker stage and received a \$25,000 investment, won the Paradigm science challenge and received another 25k as well.

**Sue Nelson**

Gosh, that's amazing. So where are you at, now? Have you built a successful prototype? What stage have you reached?

**Gitanjali Rao**

Yeah, so with Tethys I've completely taken it single-handedly and built a prototype and done all the testing that I can in the lab. And I'm currently working to find a mass manufacturer who can help with skill testing, as well as bulk production of the device for field testing.

**Sue Nelson**

Now, when you say in the lab, which labs are you using to build the prototype?

**Gitanjali Rao**

I work at the Denver Water Quality research lab, just a couple minutes away from my house in Colorado. And it has allowed me to perform all my tests in a real lab space, and at the same time, get that experience of being a researcher at the lab. And I've performed all my tests there and now I've basically gotten to a stage where I needed to go to someone else to meet its full potential.

**Sue Nelson**

How's that experience been particularly working with a company because you're getting incredible experience that many people wait probably another 10 years to get because it's sort of a mix of taking an innovation, to getting it made, a prototype, to try and to take it to market, to going through having to be forced to learn about those sort of commercialization and the business side of things.

**Gitanjali Rao**

So, business side is definitely a little bit more difficult. And it's really difficult trying to learn all of that as well. But I think that it's totally feasible. And that's the stuff that I'm working on doing right now.

**Sue Nelson**

Yeah, what are you studying at the moment? I mean, which subjects do you hope to specialise in? I'm not expecting you to say, English and drama. But who knows?

**Gitanjali Rao**

I'm not actually totally sure, because a lot of my work is multidisciplinary. But what I've recently been interested in is product design, as well as biotechnology. And so, I definitely think that's where I'll probably continue my path.

**Sue Nelson**

What you're doing this application of science and then getting something made, epitomises engineering. Do you consider yourself more of a scientist or more of an engineer? Bearing in mind of course, this is an engineering podcast, not that I'm trying to influence you in any way.

**Gitanjali Rao**

I think I'm a combination of both to be completely honest, but I feel like yeah, it would be a combo because I spend a lot of time in the research lab researching and using scientific concepts, but at the same time, I spend a lot of time designing products and ideas as well as apps.

**Sue Nelson**

And this isn't your only prototype or device that you've been working on. I was really interested to read that you'd been developing a diagnostic tool to help the early diagnosis of opioid addiction. Was that based on the same sort of carbon nanotube technology, or was this totally different?

**Gitanjali Rao**

The opiate addiction one is not based on carbon nanotube sensors. It's basically based on latest development in protein detection methods as well as genomics and genetic engineering. So, it uses you know, just a basic blood sample. Once it's pre prepared with antibodies and enzymes, you insert it into the device and the device is able to tell you again on an app, a result of are you on the onset of addiction, are you addicted, or are you not addicted at all to opioids.

**Sue Nelson**

And what stages is that at?

**Gitanjali Rao**

So right now, that is a completely prototype stage, I'm working on getting back into the lab and being able to test for that.

**Sue Nelson**

And that's quite a jump from lead detection to opioid addiction. What was it that you saw or read about that made you again, make these connections, cross disciplines?

**Gitanjali Rao**

I tend to get inspired by the world around me, whether that's on the news, or, you know, in magazines. And the only reason that jump was made is because this is the second biggest problem that I saw that was basically able to be solved, that I wanted to take a step towards solving. And that's exactly what I did, essentially. I'm also spending tonnes of time on technology reviews, and my social media feed is filled with tech just so that I know what the latest things are. And that allows me to really expand beyond what school teaches me or what little bubble that everyone else has been taught to put in.

**Sue Nelson**

It's interesting, as you mentioned, social media feed there. You've developed an app called Kindly, which uses AI to detect cyber bullying was this based on personal experience, or what you'd witnessed happen to other people?

**Gitanjali Rao**

It's a combination of both. So, I spent a lot of time looking at the news, especially when the opioid addiction crisis was blowing up in about 2019 to 2020. Beyond that, one of our family friends got addicted to opioids after a car accident, and I saw that whole family get, you know, absolutely separated and devastated because of what was going on. And by the time he knew about it, it was too late to do anything about it, which is really where I drew my inspiration from is realising that, you know, that's the issue. By the time we know about it, it's too late to do anything. And that's why I looked for a diagnosis method for addiction.

**Sue Nelson**

Now, you sound very driven, and have this huge desire to make positive change. And who do you look up to and revere or admire for the work that they do, particularly within the sort of cross discipline of science and engineering?

**Gitanjali Rao**

Yeah, there are quite a few people that I look up to. I have tonnes of friends and people like even on 'Kid of the Year' that I look up to every single day. But I think for looking at big scale role models, as well. I'm always inspired by Charpentier and Doudna, who came up with the CRISPR-Cas9 technique, and were recently awarded the Nobel Prize in sciences, which is fantastic. And that's exactly what I want to do someday, is use my innovations out here for good and see it making a difference in society. Then apart from that, I guess someone my own age, who is not really involved in science, but really empowers me every single day is actually Malala. I've never met her, but I have over social media and the work that she does is absolutely incredible and inspires me to be an activist as well with my science, because that's what's involved is creating innovations and spreading awareness.

**Sue Nelson**

Oh, Malala is an inspired choice. I agree with you totally. She's absolutely inspirational. And I can see the overlap too, between you and the sort of activism side of things as well. Now you were Time Magazine's 'Kid of the Year' from 5,000 nominees, which is an incredible achievement, you had your picture on the front of the magazine, how did you deal with that attention, and very public recognition of your interests and work?

**Gitanjali Rao**

It's definitely a little bit scary to be put out in the public eye. But I think it's been fun nevertheless. I've really been able to take this opportunity to amplify my voice and grow my platform as well. I'm seeing a lot more people really take advantage of the power that STEM brings us and find their inner innovator. And that's exactly what my goal was with this.

**Sue Nelson**

That's a great way of putting it 'amplify my voice'. That's really good. It was great to see that you've spoken at the Royal Academy of Engineering Grand Challenges Summit in 2019. And you've been doing this a lot, speaking out encouraging people, running something called innovation sessions. So how would you best describe your innovation sessions? Who are they for and what do you want them to do?

**Gitanjali Rao**

My innovation workshops range from K through 12, from anywhere from, I guess three to 500 people and can be as long as 30 minutes or go for one whole semester. So, these workshops are tailored towards each and every classroom and each and every student and they're basically able to really help students learn about my five step process of innovation, as well as really understand the world around them in a new type of perspective and find, I like to say their inner innovators. Find that driving motivation within themselves. And so these workshops are such a great way for students to come out with a solution and a process that they can use to take it into the real world.

**Sue Nelson**

And how many students have you given these innovation sessions to? I'm assuming most of them are all virtual.

**Gitanjali Rao**

With these innovation workshops, yes, most of them are virtual because of COVID-19, of course, but I get reached out to a variety of organisations and we schedule it with them. So it's more of a one on one personal type of thing with the organisation itself. And that allows for a lot of flexibility in schedule, as well as a lot of excitement from the students that come in.

**Sue Nelson**

I'd read that you've mentored over 30,000 students, I found that astounding.

**Gitanjali Rao**

I have actually, to date I've done actually about 40,000.

**Sue Nelson**

I thought there might be an update.

**Gitanjali Rao**

Which is an insane number. And I still don't know how that really came together. And it's so empowering that, you know, 40,000 students across the world have been a little bit uplifted and have understood the power that they have in this world, I like to say that I'm working towards the bigger goal of creating an innovation movement.

**Sue Nelson**

And what's the sort of best feedback that you've had, or, or results from one of these innovation sessions so far?

**Gitanjali Rao**

The best feedback that I get is when students tell me their ideas and tell me that they finally know how to make it work. I just love hearing that come out of their mouth. Because that's, that's when you know you've succeeded. And that's when you know that you're making a difference in someone's life, and when they can figure it out themselves.

**Sue Nelson**

And do you get the same sort of positive feedback from people your own age around you at school? Because obviously, it sounds like you are leaps and bounds above your contemporaries. And that can cause great admiration, but it can sometimes cause slightly more negative feelings.

**Gitanjali Rao**

Yeah, it can, I guess recently, I I'm so honoured to have a supportive friend group around me, were really allowed me to basically explore my passions. And I think that's what we all bring to the table, is just perspective. And I guess it's not leaps and bounds. And more than that, it's just the way I approach things in an innovative way. And I go to a STEM school. So some of this is a little bit biased. So a lot of kids out there are just like me innovating and coming up with ideas. But that's where I draw my passion from is my friends, my social life, the excitement that they bring.

**Sue Nelson**

That's so good and that's so lucky. Because you're right, you need that supportive network around you in order to flourish. And particularly for women, I think it's you know, it's changing. But in the past, when women have been interested in STEM subjects, they haven't always received the support they need. So, it sounds like you know, you really take this responsibility seriously in terms of being a role model.

**Gitanjali Rao**

Yeah. Yep. Absolutely.

**Sue Nelson**

That's great. And what do you do to relax though? I mean, listening to all the summit's and the talks, and you know the going to the labs, I sort of wonder whether you actually do have any spare time, but I am going to ask you, what do you do in your spare time if you have any?

**Gitanjali Rao**

The biggest thing that I've been doing recently is baking. I bake a crazy amount. I also fence, I play the piano, and I'm working on getting my pilot's licence as well, which is always exciting.

**Sue Nelson**

Oh, that's great. That's really interesting. I've been baking a lot. I mean, I love cooking anyway, but I've been doing a lot more because of COVID and lockdowns and being more at home has that contributed to the increase of an interest in baking?

**Gitanjali Rao**

It has, just being at home she really changes the way that you look at the world. So yeah, and that and the Great British Baking Show and watching that on repeat for days and nights. I think I pulled up all-nighter watching a season once. That has also caused issues in my baking career. I am nowhere close to them and do not expect to be. I can barely make brownies. I guess one day maybe I'll be on the show.

**Sue Nelson**

Oh, that's such a great programme. I'm a bit obsessed with that one.

**Gitanjali Rao**

I know, same, it's so good. It's so well produced. And my favourite part is, unlike American TV shows everyone is helping each other and on the show. And it makes it that much more funny and exciting.

**Sue Nelson**

There have actually been engineers on that programme, there was an Airbus engineer, space engineer on the show who did quite well actually. If you were to be on that show, because people often will make something that's related to that interests or their job or their personality. What would your showstopper cake be?

**Gitanjali Rao**

That is honestly one of the best questions I've received. Thank you for that. Okay, so first thing I have to say I say that I'm a huge fan of Frances Quinn. She won the fourth series, I think 2013, yeah. So, her style, basically, if you look through all of her cakes, and all the things like that is making things that look like something else. She was making breadsticks one day, and they look like matchboxes. I think she had a carrot cake, but you could cut it into it and basically take out the carrot. And that that's kind of the, that's the effect I want to go for with my work. Something that is more than just to the eyes. I want something that you know, has that whole experience because that that's really what innovation is there's a lot of layers to it.

**Sue Nelson**

Absolutely perfect. And yeah, yes those creations they sort of made your jaw drop. So, what would your advice be to people your age who are at school, and they love STEM subjects? And particularly those who are thinking of applying science becoming an engineer? What would you say to them?

**Gitanjali Rao**

So, my biggest piece of advice to anyone in that field, you know, looking to be a scientist or engineer is first dream big and then think back to reality. There are a lot of times I face self doubt and told myself to stop. But if I did, then I wouldn't be at the position I'm here today. And we're kids. So, we have that time to dream big. So, continue to do that, dream of whatever job you want in the world, whatever occupation you want to pursue, or whatever you want to pursue even in the next couple of years and make that happen.

**Sue Nelson**

Great advice. And what would your dream job be? I know, you said you were sort of interested in possibly going down the product design route. But if you could say, okay, "at this stage in your career, I like what they do". Is that Is there someone who's doing a job right now that you think, "Oh, I love that"?

**Gitanjali Rao**

That's a really good question. And I think it will be a lot of different things. But recently, what I've been very interested in and would love to do one day, even if it's not my job full time, it's just being in the control room of a rover launch. I think it brings a new type of adrenaline and I feel like my expertise would line up properly. If that's the research I was doing. I was able to, you know, watch the rover launch live and attend a couple NASA presentations as well and it changed my world forever. And I've been working with Lockheed Martin, NASA, the United Launch Alliance and a lot of different organisations and I'm fairly close with most of them too. So, I definitely hope that one day I'll be able to go back into the field and just be back there. That's like one job that I would love to do in reality, I don't know how feasible it is, but it's a job nonetheless.

**Sue Nelson**

Oh, that sounds extremely feasible to me and, and you're talking to a woman, you know, after her own heart here being a massive space, enthusiast and Perseverance rover, and the landing is incredibly inspirational. I definitely think you'll get to wherever you want to go. Gitanjali Rao, thank you so much for joining me on the Create the Future podcast, such an inspirational conversation.

**Gitanjali Rao**

Thank you for having me.