

Numberphile Podcast Transcript

Episode: The Naked Mathematician - with Tom Crawford

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Dr Tom Crawford has been known to strip to his underwear in the interests of math education. He is an Early Career Teaching and Outreach Fellow at Oxford University.

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[gentle intro music]

Brady Haran: Today's Guest is Tom Crawford, a mathematician you might recognize from some of our Numberphile videos and his own channel, Tom Rocks Maths. Tom specializes in applied mathematics and has a PhD in Fluid Dynamics from Cambridge. These days he's teaching students at Oxford University and has carved out an unusual niche doing outreach. Oh... and occasionally he teaches mathematics wearing only his underwear. But we'll get to that later.

[piano music]

BH: You don't look like a mathematician, do you?

Tom Crawford: Uh... [sighs]

BH: Like are people surprised when you...

TC: Yes, yeah yeah, no... I [laughs] fair point... I think you're right. I wouldn't look like the typical mathematician but at the same time I often like to counter that point by saying, well what does a mathematician look like? To me it's some who does maths like in any other aspect of life that can be literally anybody.

BH: Yeah... but like... for people who can't see you and who haven't seen you on Numberphile, like you have lots of tattoos... admittedly a lot of them are mathematical tattoos [laughs].

TC: Yes!

BH: But you might not know that at first sight. Lots of tattoos and you got your cool trendy long hair and lots of piercings and things like that. What do people normally think you do?

TC: [laughs]

BH: Like what do people guess?

TC: I used to play this game with my friend's actually when I was a graduate student. So we'd go out on these things, in Cambridge they're called Swaps. Basically you have a group of guys, group of girls, you all go out for a meal together and sit boy-girl around the table. Like organized fun we used to call it. We used to always have a laugh, when you know, you're sat down, you're introducing yourself, I'd often be sat near my friend Joe and we'd say, What'd'ya think each of us does? Because he looks very similar to me, he did chemistry and

I did maths. And everyone would guess, English, art was quite popular, [chuckles] occasionally like history... I don't really... I don't know but it was more something that I think had an element of creativity. At least to that people would think of as a creative type subject. But yeah not so many guesses on maths.

BH: Well, let's go back to the start then. Let's go back in time a bit. Where were you born?

TC: Warrington. Northwest England. It's about halfway between Liverpool and Manchester.

BH: Right.

TC: I say near Manchester, when I introduce myself to people because of football allegiances.

BH: Right.

TC: When I was growing up at school it was either you were a Liverpool fan or you were a Man United fan.

BH: Yes.

TC: And so because I was obviously on the Man United side, the correct side, of the divide [laughs] that I would say, I'm from Warrington near Manchester. But equally could say near Liverpool.

BH: Tom is winding me up on purpose because I am a Liverpool fan. He is a Manchester United fan. I wasn't sure if I was gonna bring it up.

TC: [laughs]

BH: You've brought it up, let's move on for now. So what were you like as a boy? Were you into maths as a boy?

TC: I think so. The main thing I do remember was I definitely enjoyed doing work. Like school work. Like as in I sort of saw it as it was fun, I enjoyed learning, I would come home and do my homework before I went out to play. I think my parents to be fair to them drilled that into me from a quite an early age that you can go out and play as much as you want just come home do your homework and then you can go and have as much fun as you want.

BH: Okay.

TC: I don't specifically remember when I was young young, like maths over anything else, but I just do remember that I enjoyed learning, I would work hard and do well at school.

BH: So you were, were you nerdy or were you just good at school work?

TC: [sighs] I wanna say... I think a bit of both. It's quite hard to think about because one of the ways I explain this to people or thinking back is... it's always interesting analyzing your younger self [laughs] in these situations but I've always been good football and because I was like... not the star player of the school football team but I was like you know one of the let's say first three names on the team sheet.

BH: Yeah.

TC: And I was playing striker, scoring the goals, even though I was like nerdy in the sense of I'd always be doing my homework, I'd always not get into trouble, and things like that, I think because I also had that kind of like the coolness of being on the school football team, perhaps was never seen as a nerd

in the typical sense. So I think yeah that's why I would say... but then at the same time like I absolutely loved Pokemon. Which is pretty nerdy! [laughs] I have loads of Pokemon tattoos, I play the video games, I collect the cards like and that is typically again a sign of sort of like nerd culture is being into fictional video game characters.

BH: But like in the Northwest if you're good at football that covers a multitude of sins. [laughs]

TC: I think so! Yeah I think it really did sort of like help me to fit in actually.

BH: If I'd come up to you as a boy and said, what do you want to be when you grow up, what kind of answer would I have got?

TC: At one point, I think I wanted to be a lawyer, 'cause I wanted like some big sort of like powerful profession. I think I was aware that I was doing well at school and so I thought oh okay what's like the biggest flashiest awesome job? Like lawyer, doctor, I think I went through phases of thinking that and then as I began to realize maths is what I enjoyed the most. So my earliest memory of that is maybe like year four so when I'm like nine or ten, maybe? I think more and more from that point on, I began to realize that maths was actually the thing I enjoyed the most. Maths was what I was best at, I think, as well and just made the most sense to me. So I started looking at like jobs for mathematicians and things and I remember at one point I went through a phase of wanting to be an actuary working in insurance and things. Because it's very well paid and you apparently do lots of maths. This is, you know, what I was told by careers advisors or, you know, internet searches. And then I actually did an internship with an actuarial firm during my undergrad, during a summer and hated it. 'Cause I was sat in an office playing with Excel. [laughs] And it wasn't at all what I thought the role was so, it was like oh I'll just test it out but that point I didn't think I'd wanted to do it anyway. Because I was doing well at school and as I say I think I was aware of that, I wanted to sort of aim high and also obviously I

wanted to be a professional footballer. [laughs]

BH: I was gonna ask, like, [laughs] right, for Manchester United of course?

TC: Like yeah... well ideally I did have trials at Bolton Wanderers when I was about 10 or 11.

BH: How'd that go?

TC: I didn't get in.

BH: Aww.

TC: I got picked. I got scouted, you know, they would come to the games so like I got invited to come on to the session and the team I was playing for at the time I think three or four of us got invited 'cause we were doing quite well in the league...

BH: Yeah.

TC: I was part of that team and I think two of the other lads did get in. And I didn't

BH: Aww, and you missed out.

TC: I know yeah.

BH: Did you just have a bad day that day, or were you not good enough?

TC: [sighs] well [laughs] one of the things... I do think I was good enough. I think... I'd like to think... I'm reasonable at football. I'd always use to get that I wasn't aggressive enough.

BH: Right.

TC: That is what my managers and my coaches used to... because... I just don't think I am very aggressive person. In general I'm like try to be positive, try to be happy, smiley. And when you're on a football pitch playing against angsty teens I didn't really have that like the Rooney-esque kind of like anger thing.

BH: The killer instinct.

TC: Maybe the killer instinct. Maybe I was missing that to be a [chuckles] proper professional footballer.

BH: So it sounds like the realization that mathematics was in your future came quite early then? You were quite young, it wasn't like right at the last minute of high school or anything?

TC: As I said, I think it just made the most sense to me. My brain tends to work in patterns. It's often... it can be quite hard to explain this [laughs] because obviously everyone's brain works in it's own sort of way.

BH: Yeah.

TC: When I see the world and I experience it, I tend to see patterns in things. I tend to be almost like focused on the numbers. I think that's why I really like Pokemon, actually.

BH: Right.

TC: [laughs] Just to bring it back. Because there's a certain number of Pokemon, and I want to always get those... all of them and the whole game is quite based around numbers and patterns. And I think... in general that kind of

like appeals to me and that's how my brain works so, yeah I think my earliest memory I was like nine or ten, year four, and was just doing like long multiplication for fun.

BH: Right. Were your parents mathematical? Were they like mathematical role models for you?

TC: I hope they don't mind me saying this but I wouldn't say they were. They were definitely role models in the sense of working hard and everything else but definitely not mathematical role models. So my mum is a cashier in a bank, she just works in a high street bank, and my dad is in the construction industry. So sort of manual labor, he's a thermal insulation engineer for the fancy title.

BH: That sounds good.

TC: That's just when he's trying to show off. [laughs]

BH: Right. [chuckles]

TC: He fits like lagging and insulation and he is sort of hands-on.

BH: And they didn't go to university?

TC: No, so they didn't go to university, they both left school as soon as possible and wanted to sort of start earning money.

BH: Right.

TC: As for whether they were clever... I think they are quite intelligent people to be fair of them [laugh], they'd be probably quite offended if I said they weren't.

BH: Yeah.

TC: But I really think they and I genuinely mean that.

BH: Yeah.

TC: They just for whatever reason fell out of education as early as they could and never had the desire to go to university.

BH: You did go to university.

TC: Yes.

BH: And tell us where you went.

TC: So I came to Oxford University.

BH: Right.

TC: Which, I think I remember getting my GCSE results at 16 and doing pretty well and sort of my teachers saying to me, have you thought about Oxbridge? Oxford or Cambridge and that was maybe the first time I'd sort of, 'cause almost like GCSEs are the first big result you get. You've got like school tests but it's like GCSEs actually can in theory get you a job and things.

BH: Yeah.

TC: So that felt to me like, I'd done well and I was like maybe this is you know, I want to aim for the top. I want to go for this and so I settled on Oxford.

BH: And this was... was this common for people at your school or were you...?

TC: No, so I was just in my local state school, 'round the corner. It was literally just my local school, my friends went there. There was talk when I left primary school, I remember... I do remember a discussion with my parents, as much as you could maybe have this discussion at eleven, [laughs] about did I want to go to a grammar school, could I had been doing well at school. And they said, you know, we can send you to this further away you get a bus everyday, but I was like, no it's fine I wanna go and keep hanging out with my friends. I wanna just walk to school everyday.

BH: Yep.

TC: So I just went to my local school. I know I think I was one of the first people from my school to end up going to Oxford or Cambridge. And I remember coming down for the interview, so the dreaded Oxford interview. Obviously now I now do the interviews, I have to say this, but it isn't as bad as you think, but obviously it is also slightly terrifying as a seventeen year old in a room with three or four potentially world famous professors in your subject.

BH: Yeah.

TC: It's... and I remember the morning of the interview and I... well I was a little, of course, nervous, and my mum I don't think helped because she had this kind of as most mum's would this mindset that I was like a... I wouldn't fit in. She was like you're gonna just be treated as like the Northern miner's son.

BH: Right.

TC: Kind of...

BH: Billy Elliot or something...

TC: Yeah, yeah! Basically. I think she'd... yeah she thought Billy Elliot was real. [laughs] And so she had this... and of course it's not like that at all. There's a very wide range of people, as in any other university, and but of course I was quite nervous and I was going for a walk before my interview. I think it was reasonably early in the morning which I didn't like but it was like ten AM and I'm walking around the gardens of St. John's College where I had applied and was having my interview. And I just do remember... I can still remember this feeling. I'm getting goosebumps actually thinking about it. Like walking around and looking at the five hundred year old buildings and being like... this is awesome. I really really really like... c'mon... like kind of like psyching myself up like...

BH: Right, I wanna get in now.

TC: Yeah! And I feel like some people almost see that as like overwhelming. That could sometimes put people off. Where you see it and think, this is such a historic place. All of these amazing people that been here before me. But for me it was very much like psyched me up and sort of game face on like let's go. Let's do this.

BH: If you're someone, you know, your parents hadn't gone to university although they, you know, encouraged you, they hadn't gone to university themselves. And you sounded like someone who wanted to be with your mates, you know, you chose school with your mates rather than the posh grammar school further away. It sounds like you could have been someone who would stay where you were, like rest on your laurels. You obviously do have some self motivation, some drive in you?

TC: Yeah I think so. And I think... I think it's hard to pinpoint exactly where that comes from but I do have this idea of... I don't think I need to be the best or anything in that sense, but I kind of... if I'm doing something I want to try and excel at it as much as I can and I want to aim as high as I possibly can in

whatever it is that I'm doing, really. And I think that was particular true when I was sort of going through my education. And I think I probably obviously can't really think like this when I was eleven and I made this decision between the school but I'd like to that... and I think this is why my parents sort of didn't in any way push me because they were sort of being told by my... well not told... hinted by my primary school to say, Tom's pretty clever like he could do really well here if he went... he could get into this grammar school and things. I think they saw that I had enough self motivation that I would still be able to have fun and I would make sure that I still did the work and still worked hard and studied.

BH: What were you teachers and your parents reaction when you got into Oxford?

TC: [laughs] Very very very funny... I'm so glad you asked this question. I haven't thought about this story in about five years. So we got a phone call, we're all having dinner, on like a Friday night, I think it was two weeks after my interview. And the phone goes, and obviously it's the middle of tea as we would say, so my dad wasn't very happy. Because he was being disturbed from his tea, so he goes up he answer's the phone and he's like, yeah what? Kind of like rougher, blunt on the phone. And then it was like, somebody who introduced themselves as this is professor Charles Batty from the University of Oxford, and so my dad goes... and then they said can I speak to Thomas Crawford? And my dad was like, I think you want my son then. And he was like, yes I think so, because my dad's also Thomas Crawford just to confuse everything. And so then he like shouts me over and he's got like this look on his face because he's thinking that I'm in trouble. 'Cause he's thinking I've gone down, you know, to the interview session two weeks earlier and like I'd kind of told my parents that... 'cause I'd just turned eighteen the week before my interview, I went out and bought us all some beers, we'd had a bit of a party in the room where I was staying with some of the other students, you know, we'd all done our interviews we wanted to like let our hair down a little bit. So we had a few drinks. So he

thinks I'm getting in trouble for like the state... it wasn't bad... the state that I've left the room in...

BH: [laughs] You'd trashed the hotel room afterwards, right.

TC: [laughs] Basically, so that's what he's got in his head.

BH: Yeah.

TC: So he like hands me the phone and then I'm just, you know, I'm having a conversation, and he's like proper starring at me. And I just get off the phone and I'm like... I'm in. Like this is you know Professor Batty who'd interviewed me to tell me that I'd been offered a place and then just... and then he just immediately is just like... no way... and then my mum's like saying oh get the champagne and then goes and, you know, grabs a bottle of champagne.

BH: [laughs]

TC: It was such a surreal... but like [laughs]... because when I picked up the phone I was like oh no I'm in so much... like... because just the look on your dad's face you're like... I am in so much trouble right now.

BH: Oh right... [laughs] I want to hear more about this party where you trashed the room.

TC: [laughs]

BH: But anyway... [laughs]

TC: We didn't trash the room! I think I just left a big bin bag of beer cans. It wasn't trashed.

BH: Okay.

TC: It was just but... you know that there are rules in place now where you're not allowed alcohol at all on site.

BH: Right.

TC: Understandably. But this was back in the day. [laughs]

BH: Okay.

TC: Because I was 18 so I could buy it and then... [chuckles]

BH: Right, [laughs], a bin bag of beer cans.

TC: [laughs]

BH: That could be a podcast title. [laughs]

TC: [laughs]

[gentle piano music]

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[gentle piano music]

BH: So you come down to Oxford, what, studying mathematics, presumably? Right?

TC: Yes.

BH: Was it like Billy Elliot... you know, were you the northern coal miner boy or what did it feel like when you got here? What was it like when you first started?

TC: It was a shock to the system, in the sense of the work. Nothing at all to do with the northern... the Billy Elliot northern coal miner. That as I think I didn't actually believe that... but my mum... when my parents came down to drop me off I think they immediately realized that everyone else is from all over.

BH: Yeah.

TC: So the way I used to describe it to my sort of home friends. The easiest way I felt to explain it to them was I said there's about a third of the people are sort of your went to private school... et cetera... group... you've got sort of...

BH: The posh sort off...

TC: Yeah let's call them posh, yeah. [laughs]

BH: Yeah, okay.

TC: I'm trying not to offend anyone because I had lots of friends who went to those schools.

BH: Yeah, yeah.

TC: And then you had like a third of your people were kind of your... let's call them typical nerds.

BH: Yeah.

TC: Like just kind of all they did was sit in their room and work kind of, as you would expect 'cause

BH: Yeah.

TC: At a, you know, elite university. And then I said and about a third are just me.

BH: Right.

TC: Normal people, I would like to think, normal person, you know, people you want to hang out with. Not that the other groups aren't people you want to hang out with but that was what I found was the easiest way to explain it.

BH: Right.

TC: To all of my home friends.

BH: So you're the normal, Manchester United, Pokemon obsessed... [laughs]

TC: Yeah! [laughs]

BH: I don't know how normal you... [laughs]

TC: Now covered in tattoos, exactly that.

BH: Yeah, alright [laughs].

TC: But no the work was kind of... that was a shock.

BH: The amount or how hard it was?

TC: I think a little bit of both. But mainly the amount.

BH: Right.

TC: It was intense. I certainly remember... I obviously did quite well but it took me, I think, that first term, I certainly remember lots of like three, four in the morning, three AM, four AM, finishing off problem sheets to hand in and things. Then having to get up at nine AM for lectures. It felt like I hadn't quite yet figured out. It's that adapting period. I'm sure everyone goes through this when you go to university, you've gone from fixed working hours at school and things to suddenly now you're in charge of your time.

BH: Yeah.

TC: But one of the things that sticks with me was during my A Levels, so I did Maths and Further Maths. Double Maths, and in Further Maths when I did the course there was an option called Further Maths 3 which was optional...

BH: Back at high school...

TC: This is back at high school.

BH: For our American friends who don't know what A Levels are.

TC: Yes, yes this is back at high school. So i'm seventeen and there was... you

had to pick six maths modules that made up this qualification.

BH: Hmm.

TC: And one of them called Further Pure 3 was optional and it's quite difficult.

BH: Hmm

TC: So... [chuckles] I was very much of the position I was in of thinking well why make this harder for myself than I need to? I'm just gonna do Additional Statistics because Stats was known to be a bit easier.

BH: Yeah.

TC: Than doing this... perhaps more interesting but harder course. But anyway it turns out that course contained matrices.

BH: Yeah.

TC: So I had never seen a matrix. And when I turn up my very first lecture... the lecturer just like starts writing all these matrices on the board [chuckles] and I just remember sitting their in the lecture theater and turning to my friends next to me and being like I have no idea what this is.

BH: Right.

TC: Like... I'm like what is a matrix? And they're kind of like laughing, and I'm like no, no seriously, is this like a vector, like what's... 'cause I'd just never seen it before.

BH: Yeah.

TC: But and so I had to actually spend the next week basically learning Further Pure 3 because I was worried that I'd missed other stuff.

BH: Yeah, yeah, yeah.

TC: So I went through and sort of like, you know...

BH: That could be really scary if everyone in the room knows what a matrix is.

TC: I think there was some other people who maybe didn't as well. I don't think I was the only one, 'cause there was like two hundred...

BH: Yeah.

TC: But I remember my two friends next to me were like did you not do Further Pure 3? And I was like [sighs] no it was optional! Like... [laughs]

BH: Right, [laughs]

TC: I took the easy route. [laughs]

BH: Okay. How quickly did your perception of mathematics change when you came to university from like... solving problems to that more kind of, you know, proofs and the beauty of maths and things we hear about? Did that hit you immediately or does that come slowly or?

TC: My perception certainly changed. Whether it was to do with this beauty aspect... whilst I not had much experience with proof because you don't really when you're in high school.

BH: Hmm.

TC: You do a little bit, but it's very much just a taster. So there was certainly that's another thing that I see now with all my first year students. A lot of them struggle with that... that's very new and that can take a while to actually get into that mind set.

BH: Hmm.

TC: So yeah there was definitely that aspect of it but the main I found that changed for me was if you'd asked me when I was starting or when I was applying why I was going to do maths it was always like I'm just gonna do pure maths. I love like maths, numbers, thinking I was going to be like proofs, prime numbers, that kind of stuff.

BH: Hmm.

TC: And then when I actually started to study the whole range of subjects which brought in applied maths, so things like fluid mechanics, which eventually I went on to do my research in. That appealed to me a lot more. But when I was seventeen, eighteen... I remember actually talking to my dad about this, 'cause we went to an open day at Oxford and there was somebody talking about prime numbers and then we had a second mini talk which was about like I think it was like the aerodynamics of rockets. And afterwards my dad was like I like the rocket one.

BH: Yeah.

TC: 'Cause I guess he's thinking he can kind of picture a rocket and have some kind of idea but like prime numbers he was like I was lost. Whereas I was like oh I loved the prime number one, and I was like I don't really care for that applied rocket thing. [chuckles] Which is now really quite funny looking back

when I'm so much on the other end of the spectrum. When all I...

BH: Right... you became your father's son.

TC: [laughs] Yes, very true.

BH: Yeah. Did you ever have any doubts when you started at university. Were there any of these sort of crises of confidence or have I chosen the wrong path or did it always feel like yeah this is cool?

TC: I always felt like I was on the right path. I think I knew maths was like yeah by this point I was doing the right subject. I definitely can remember a couple of points in my first year where I was like this is hard.

BH: Hmm.

TC: Like because of the workload. You know being up til three, four AM. And also just some of it... something that's really hard to get used to as transition from a high school student who has applied to Oxford or Cambridge or another very good university. And then coming to the university is you're no longer going to get everything right.

BH: Hmm.

TC: So I kind of gone from doing my high school work where if I didn't get a hundred percent I'd be like oh c'mon you can do better than that kind of...

BH: Hmm.

TC: Whereas then you come to university and it's like if I'm scoring above sixty or seventy [laughs] if I'm scoring above seventy I'm getting the top class mark I can get. First class is seventy and above. And I think that took a little bit of

transitioning. Yeah maybe because I had been so used to you're the big fish in the small pond to being the many fish in the bigger pond kind of vibe. That maybe shook my confidence a little bit. And as I said I think it was that adaptation period in first year, so like, for example my exam scores in first year were the lowest of my years. Right, so I did better in second year, third year, fourth year. And I think I really was adapting but they were by no means bad.

BH: As you came towards the end of your undergraduate degree, what are you thinking? You're obviously starting to develop more specialized interests and thinking about what's next. Tell me how that unfolds.

TC: Actually goes back to probably my second year and I think that was the first time I'd ever heard about a PhD.

BH: Really?

TC: Yeah I had no idea. I mean no one in my family had really been to university. Obviously some of my friends went to university but I'm the older sibling so I don't know it just never really come up. I knew you could studying maths to become a Doctor of maths but I just hadn't quite realized how that happened.

BH: You just didn't know how the system worked?

TC: Yeah, yeah.

BH: Hmm.

TC: And then I began to realize and look into a lot more during my second year of my degree, this idea of a PhD. And the concept that I could keep studying after my undergrad, and actually be paid to study this time, not have to pay fees, was awesome. So I think once I found that out, and I was still enjoying what I

was studying and everything, it felt like, I dunno I think I kind of went towards that path sort of during my second year.

BH: Right.

TC: And so I became aware it existed and then in terms of figuring out what I was gonna do and I also think it fit in actually towards the end like let's say start of my fourth year when you're... 'cause you do a four year course here, you do three year undergrad and one year Masters. And everyone can stay for the Masters as long as your scoring at least sixty and above in your exams. So I stayed for the Masters and then I felt like I wasn't ready to get real job. [laughs]

BH: Right

TC: Kind of like now! [laughs]

BH: [chuckles]

TC: It's a recurring theme. And so the fact that I could keep studying everything meant I was like right I'm gonna do the PhD and then it was a case of figuring out what to study, and I just thought about what have I enjoyed the most so far. And again, it started in my second year when I did my first taste of fluid mechanics and then I picked a quarter of my third year was fluids and a quarter of my fourth year was fluids. Which was as much as I could do. Because I just really enjoyed it.

BH: Do you think that was because of an innate interest in the subject or did you have a particularly inspirational teacher or...?

TC: I think it's both.

BH: Yeah?

TC: I think it's that I remember my lecturer in second year was really good actually. He was a really... he just had a like passion and he was also a very good lecturer. 'Cause some people can have a passion or can be very good mathematicians but lecturing is a whole other skill. So I think he had that kind... you could tell he really enjoyed what he was talking about. I really enjoyed learning it, 'cause it had sort of... I could see visualize and see the applications of these discussions about interfaces, rivers, climate, I could kind of see it all realized before me.

BH: Hmm.

TC: And so I think there was certainly that aspect that I had the lecturer but also as I just mentioned like... the fact that it just yeah... that I felt it was so practical, felt to me like a nice... and then when I was actually looking at PhDs, I actually spoke to some of the other tutors at St John's. It was actually an engineering tutor, I remember going to his [laughs] it's quite funny... I think it was like one day after formal... we like... I mentioned to him I think via email that I wanted to chat and he said oh come to formal on this day and then we'll have a chat afterwards and we were like...

BH: What's formal?

TC: So like formal hall. So the fancy... where you go to dinner in your like gown and they bring you like a three course meal. Like the most ridiculous Oxford thing ever, and as a student at the college it cost you about four pounds so obviously you did it pretty much every day because why would you not want a three course like... [laughs] amazing meal. So it takes about an hour and a half, you know, you have to kind of plan around having this whole incredibly cool experience. And I think it was just after a formal and then we were literally like just one of these crazy experiences that almost doesn't feel true where you're just like sat in this very ornate room where you go to after formal. Like literally

drinking, I dunno, port or whiskey or something and just having a conversation with some amazing professor in engineering about fluid mechanics. And he just mentioned that in his opinion the best place in the world to study fluid mechanics was Cambridge.

BH: Hmm.

TC: And I found that in Cambridge they had a laboratory. And now this is something else that really caught my attention because I'd never done experiments before. And I was like, so I can do maths and I can do experiments which sounds kind of fun.

BH: Yeah.

TC: And it's in fluids... and sort of and that kind of led me then to go to Cambridge, well to apply to Cambridge and then do my PhD.

BH: So you got your undergrad and a Masters at Oxford?

TC: Yes.

BH: And then a PhD at Cambridge.

TC: 'Cause I fancied a change. [laughs]

BH: Let me ask you about... fluid mechanics. I don't want to go into all the details of what you studied, we've made videos on Numberphile, people can go and watch them. It's all really interesting. But I always sort of think that the study of, you know, rivers and water and all this mushy messy stuff doesn't seem a good match for the exactitude and precision of mathematics. Is the mathematics of Fluid Mechanics a bit hand wavy or is it really precise and perfect like I like to think mathematics is?

TC: It's kind of both. I think you're onto something with saying it's... there's a lots of approximations for sure. Again as you said we've talked a little bit before in a Numberphile video about the Navier-Stokes equations and they are based on fundamental laws of physics. So conservation of mass and Newton's Second Law of Motion. So kind of the grounding is sound. Now the problem is when you plug in the required bits for a fluid into those two laws of physics you get very very very complicated mathematical expressions. Which is the Navier-Stokes equation. And we just don't really understand those equations. So that's why there's a million dollar prize, one of the Millennium problems. And I read that book when I was a kid, actually. When I was sixteen, when I was applying to university I read the Millennium Problems by Keith Devlin. Awesome book, explains all seven problems to like understandable for a like sixteen year old. So I wonder whether that played a little bit into my [Laughs] choice to go into fluids that I knew maybe there was this chance, I don't know, of like a million... I never studied it in that sense but that kind of hints that the maths... the equations themselves I think are solid because they are based on laws of the universe. But then because we can't at the moment we don't have the mathematical tools to properly tackle them, what we have to do is then make simplifications. Make assumptions, simplify things, as you say to kind of make it all work. So it's not quite precise but I think for me I enjoy the fact that you can make these simplifications. So you're studying a problem and you're like ,oh gravity doesn't matter here, and like a normal person be like well it clearly does because everything isn't floating, but for the fluid it doesn't matter because the answer we get then we compare it to the real world or we compare it to the experiment and it's the same. So I think I like that insight you can get about what approximations or simplifications work.

BH: So when you're at Cambridge and you're sitting in labs presumably doing things with liquids and water and thinking about rivers and all that kind of stuff that you did, what job did you think you were gonna end up doing? What was the plan?

TC: [laughs] Was there a plan is the question? [laughs] I think I decided I wanted to do the PhD, definitely wanted to keep studying and when I started my PhD I was absolutely certain that I was just gonna keep studying maths forever.

BH: Right.

TC: And then partway through my PhD I began to realize that mathematical research... research in general... I wasn't sure that was for me.

BH: Why?

TC: So I think... or one way I like to think about it is... one of the main reasons that I'm attracted to maths is that there's a right or a wrong answer.

BH: Right.

TC: You know? It's not like writing essay, and someone think's it's fantastic and then somebody else... that can be quite... there are certain things, right, whether or not you're using true statements and things but generally it's quite... subjective.

BH: Yes.

TC: Whereas with maths its like, this is the answer. [chuckles] You can get there in different ways and that's where the creativity comes and I do enjoy that, and this is something I definitely try to hammer into my students. [laughs] You can be very creative with how you get to the solution but once you get there it's a tick or it's a cross.

BH: Yeah.

TC: And I think I enjoyed that. I think that fitted in with how my brain works, almost.

BH: Yeah.

TC: But then when you're doing research you can like... you get to an answer and you're like I think this is right... like... the experiments seemed... yeah it kind of fits.

BH: There's no answer in the back of the book.

TC: You don't... yeah there's no... yeah you just don't know anymore.

BH: Right.

TC: And it's very difficult even to prove it. Even if it's a proof rather than answer. When you're doing research you are literally at the forefront. You're at the boundary. You're pushing forward the knowledge.

BH: Hmm.

TC: And so you don't actually know if its right anymore. And I think that may have played a role into perhaps why I didn't quite enjoy it. I mean I did enjoy my project.

BH: Yeah.

TC: But just the general feeling of research, and also like focusing on one area, I've heard people like describe doing a PhD as being like you basically become the number one expert in the world on your incredibly niche... like the title of your thesis you are officially the world's expert on... what's mine? Experiment... [laughs] Experimental Study of the Input of Buoyancy into a Rotating

Environment.

BH: Right.

TC: So I'm quite possibly the world expert on that.

BH: Yeah.

TC: But... that is so niche and narrow. And I think I kind of miss the variety and the bigger picture stuff rather than just doing the same thing all day everyday. Even though I could... something that was good about my PhD was I could do an experiment and if I got bored of being in a lab I could go up to the office and do some calculations.

BH: Hmm.

TC: And switch between them. So I had a bit more variety than most normal mathematicians perhaps. But I still didn't feel like there was enough in terms of the content.

[gentle piano music]

BH: What did you line up next?

TC: Well I didn't know what I was gonna do. [laughs] And I sort of almost by accident we got an email sent round just like departmental mailing list advertising a work placement and specifically the funding was for I think it was actually super specific for a maths or physics PhD student at the University of Cambridge.

BH: Hmm.

TC: So I think it was maybe partly funded by the uni or something. And it was to go and work with a production company called the Naked Scientists who make a weekly radio show for the BBC.

BH: Hmm.

TC: To basically to go and make science radio for the BBC.

BH: And why did that appeal to some northern lad who was studying fluid mechanics at Cambridge?

TC: It sounded cool. I think is the only... it's not [laughs] the most... the best answer but I think that's the only way I can describe it. You get an email sent to you that tells you, you are eligible to apply to go and like I dunno be a journalist for two months. Like it just sounded like whether or not I like this, this sounds like it would... I'm gonna learn something from this. I'm gonna enjoy this experience. And even if what I learn is I'm not made out for this, or this isn't what I actually like.

BH: Yeah.

TC: It just seemed very cool. It's quite hard to pin down but I just remember getting the email and thinking yeah I'm gonna apply for that.

BH: I mean the Tom I'm talking to now and we'll get to this later obviously, you know, does Youtube stuff and all this outreach. Up to that point, up until you'd received that email had you already started getting bit of taste or an eye for outreach and media and stuff?

TC: So, not so much media. So in my... I think it would have been my second year of my undergrad, I joined an outreach group at the university which was called Marcus' Marvellous Mathemagicians.

BH: Right.

TC: Quite a mouthful, or M cubed for short. [laughs]

BH: Right.

TC: And we were a group of there was maybe like nine or ten of us. Kit was one of them. Kit Yates, who's also been in Numberphile videos recently.

BH: Yes, yes.

TC: Yes. So Kit was actually obviously a bit older than me but he was in the group with me. Which was quite cool, that's how we know each other. So I joined this group, just again it just sounded interesting to go around school's and science festivals and present cool maths. So it was kind of you know you're going to school and doing like a lesson, a one hour workshop, or at like a science festival you'd do maybe like again stop people on the street and being like come and look at this awesome thing and then don't tell them its maths until the end, and then they're like oh wow I just learned some maths.

BH: Cool.

TC: And So I kind of did that a little bit and during my undergrad for sort of a couple of years.

BH: So you went off and did this radio show at the BBC, that sounds like it was fun. What happened after that?

TC: Well yeah it was fun, that was the... so I went into it as you say with really without a plan and this was the end of my third year of my PhD, so I had one year left. Fun thing... PhDs at least in the maths department in Cambridge

you have to submit on the 30th of September of your fourth year. 'Cause the year starts at the 1st of October.

BH: Right.

TC: When you start the academic year. And I submitted my thesis on the 29th of September [laughs] of my 4th year.

BH: Right. Had a day to spare.

TC: Exactly and that's what I say I feel like I nailed it, 'cause I dragged out... I absolutely milked that funding as much as I could.

BH: [laughs]

TC: 'Cause if you finish early you lose your funding, so I was like no I'm gonna take four years.

BH: Okay.

TC: I'm gonna make the most of being a graduate student with lots of free time and things.

BH: Was there not a career option for fluid mechanics? Could you not go and be like a, you know, a hydrographer or I dunno... what you do?

TC: Yeah, absolutely. Hundred percent. But I don't think I had got to the point yet of thinking that. 'Cause I did this internship at the end of my third year which is about when you're thinking what am I doing in a years time?

BH: Right.

TC: It's kind of like you're entering the final year of your current thing. You begin to think what's next. And almost... I was very fortunate in that I enjoyed the placement so much like it just didn't feel like a job.

BH: So the BBC thing sort of ran concurrently with your last year of your PhD?

TC: So it was two months.

BH: Okay.

TC: So I took two months out. So yeah I had to get my supervisor's approval. Fortunately I had the most awesome supervisor I could have... he was very much of the... he's like he would say yeah that sounds cool if you think you'll enjoy it, you'll learn something.

BH: Yep.

TC: Go for it.

BH: Okay.

TC: He was very very sort of supportive and relaxed and everything else.

BH: So you get to the end of your PhD and you have done this BBC thing. What happens then at the end of your PhD?

TC: So I'd enjoyed it so much at the end of the two months, I had a chat with the person in charge, my boss. And sort of, you know, sort of I guess it's classic end of internship. How was it, blah blah blah, feedback thing. And I basically said I've absolutely loved this. Is there any possibility of me coming to do this after my PhD?

BH: Yeah.

TC: Sort of I sort of tried it out for two months and thought this is awesome, I want to do this.

BH: Yeah, yeah.

TC: And fortunately, they'd obviously enjoyed having me... [laughs] 'cause they turned around and said well... [laughs] but it had gone pretty well and...

BH: Yeah.

TC: And sort of I'd fit in and everything so we set up this idea that I was gonna go and work there after my PhD. There was a few hurdles we had to jump over. We had to find some money to basically employ me, which I managed to do.

BH: Mhm.

TC: And various things and we set up this position. And it was a one year position after my PhD... minimum one year to start with. I was gonna go and I was gonna go and make... get more maths content into the show. And also we were gonna branch out a little bit into trying to do some video stuff as well.

BH: Hmm.

TC: Just because I sort of said lots of the maths things... it needs like if we're talking about an equation or a shape, you kind of need to see it.

BH: Yeah.

TC: It's like, you can do some stuff purely based on the radio and with audio but you sometimes you need that visual aid.

BH: Yes.

TC: So that was kind of the plan. [sighs] So I went there and did that after my PhD.

BH: Okay. You're not there now so what happened after next?

TC: [laughs]

BH: So tell me what's the next step?

TC: So about six or seven months, we're still lovin' it, still really enjoying the job and I kind of I think of sort of missed... actually doing maths.

BH: Right.

TC: So even though I was able to pick and choose the topic I was covering each week and I would if possible I would try to cycle to keep that variety, I'd maybe be like chemistry, I'm gonna do a chemistry interview this week then the next week I'll do something biology, then maybe we'll do zoology, I'd go talk about birds. And I'd try and keep a bit of variety and of course trying to do maths as well, because that was mainly why I was added. They wanted to bring me to help get more maths into the show.

BH: Hmm. Hmm.

TC: I just kind of... I think I missed doing actual maths. And so I began to think well... how I can do actual maths but in this kind of media context.

BH: Mhm.

TC: And then that's when Tom Rocks Maths was born. Shall we say.

BH: Yeah?

TC: My mum came up with the name, by the way. [laughs]

BH: Okay, nice.

TC: So I was trying... I wanted like something to do with maths and something to kind of do with like... I'm a wannabe rockstar, right? [laughs]

BH: Yeah.

TC: I'm not a rockstar at all.

BH: Right.

TC: Like I have no musical talent.

BH: We have got a guitar in the room next to us, I do notice it.

TC: [laughs] We do.

BH: So you're like rock n' roll Youtube math channel name was named by a bank teller?

TC: Yeah! It was. It was named by my mum. Yeah.

BH: [laughs]

TC: I was trying all kinds of ideas.

BH: That's so un-rock n' roll. [laughs]

TC: [laughs] I know.

BH: So you started making Youtube videos, you know your Youtube channel and we'll come on to that in a minute 'cause there's a few things I want to ask you about that but you started making Youtube videos. Obviously that's not an easy thing to make money from, I can attest to that. [chuckles] What did you do... what were you gonna do about a job though? What happened then?

TC: So I started doing this in evenings, weekends, with my full-time position. And then I began to realize that I enjoyed the Youtube side of things more than the radio stuff.

BH: Yep.

TC: 'Cause, quite I think rather hilariously, I don't listen to podcast or the radio. [laughs] My job was to make a podcast slash a radio show. So I, you know, other than having to listen each week to give feedback on that week's show, I... felt like... but what I did do was consume Youtube content. I watched Youtube videos.

BH: Yeah.

TC: So I felt like I was... that felt more at home to me, felt more comfortable. And so I then began to then think how can I make that, as you said, like 'cause I'm not gonna make money from it but like how can I make that part of what I do. Or what else can I do that allows me to have more time to focus on that? And that with me also missing doing maths properly it kind of came to me again through a job that was advertised via email. I seem to do quite well off this. Was

about going... it was a teaching position purely just lecturing, they call it in Oxford, it's a lectureship, and it was at St. Hugh's College and so I thought oh I'll apply for that because it was 8 hours a week, during term time. So it was eight hours of teaching with the prep and everything you may be looking at twenty to thirty hours of work a week, but that's just for three lots of eight weeks. So twenty-four weeks of the year. And then the other twenty-eight, do what I want.

BH: Right?

TC: But obviously the salary was like... half of a normal full-time salary because you're sort of only working for half of the year.

BH: Okay.

TC: But I decide it would just about, I sort of did some rough calculations. I had little bit of savings and I was like I can do that for a year and live off the teaching thing and have six months of the year to really get stuck into the Youtube stuff and let see where it goes. So I kind of pieced together little things.

BH: Yeah

TC: To kind of make some kind of a... yeah... like a job almost.

BH: So you were like half-time teaching Oxford students, half-time just doing your own thing with Youtube content centered around mathematics and that... what's after that? Do we... is that still what you're doing now or is that...?

TC: So I did that for a year, as I said, the St. Hugh's position was for a year, and then after that year I then realized... well my money had run out [laughs] so I was like right, what I'm gonna do is I'm gonna get two of these teaching gigs. So I'm gonna do instead of doing, let's call it, twenty hour weeks or thirty hour weeks, I'm gonna do forty to sixty hour weeks.

BH: Right.

TC: Which is obviously intense. But it's only for eight... for twenty-four weeks of the year.

BH: Right.

TC: And then because it's two of them added together it equates to like a full-time salary. So I ended up getting a second one... the St. Hugh's one was renewed and then I got a second one at St. Edmund Hall.

BH: Right.

TC: Which is another one of the Oxford Colleges. But teaching the same stuff, so the hours actually weren't quite double, because I was generally teaching the same courses. So I just had twice as many students and so... I then did that for two years both of them.

BH: Yeah.

TC: Back to back so I figured well I need to make this an actual permanent job because [laughs] I had been on a year by year contact until this point and whilst there's... I certainly saw pros in the freedom, didn't feel like I was tied down or anything. I was like, well you know, I probably should maybe... it'd be nice to have a proper contract and things. And fortunately... so I'd been at St. Edmund Hall or Teddy Hall as we affectionally refer to the college for two years and I remembered when I started they'd actually... they just had a new principal at the college who's kind of in charge of the overall view of the college.

BH: Yeah.

TC: And she was really supportive of what I was doing and along with the senior tutor, who's another sort of senior person within the college, we all sort of had a chat and figured we were all on the same page. They wanted me to be more closely associated with the college, 'cause they wanted to make the most of my... online presence let's say in all of the talks at schools and things I was already doing, could be now come under their remit.

BH: Yeah.

TC: And for me it was like, this is great because I wanted a more permanent home as it were like. Rather than having several colleges and being spread out I wanted to be like, my college is Teddy Hall, this is like... you know... my students are there, this is me. This is like where I belong.

BH: In case anyone's confused at this point the way that Oxford University works is it's broken up into all these sort of colleges, these little fiefdoms within the university, so you're still kind of working for Oxford University, as people would know it. Just what part of it you come under.

TC: Yeah there's thirty-two of them or something I think. [laughs]

BH: Okay so they create... they've create a more securer role for you, and how would you described that role?

TC: Yeah. So my official title is Early Career Fellow in Teaching and Outreach.

BH: Right.

TC: So the Early Career Fellow position is a reasonably standard position in Oxford.

BH: Hmm.

TC: It's something that you get... it's like a Post-Doctoral position. You do your PhD, maybe you do a couple of other Post-Docs but you then hopefully have enough to then apply for an Early Career Fellowship. It's a three year position and you would normally do a bit of teaching and it allows you to really focus on your research to kind of create a real research portfolio to then go for like a more tenured position or something beyond that.

BH: Yeah.

TC: And here what we've done is we've replaced the Teaching and Research with Teaching and Outreach.

BH: Yeah.

TC: So what it kind of, you know, there's like a formal thing of what this means but what I've interpret it as and what they're happy for me to interpret it as is all of the stuff I do with Tom Rocks Maths is now just actually part of my job.

BH: Yeah.

TC: So all the Youtube stuff, doing this podcast here with you. [laughs]

BH: Yeah.

TC: Is now part of my job basically. And they've been really really good in giving me like... they've trusted me to be like just every now and then let us know what you've been up to.

BH: Yeah?

TC: So they can sort of document it.

BH: Well they can just go and watch the Youtube videos.

TC: All that, yeah. [laughs]

BH: Let me ask you about the Youtube videos. You take your clothes off... in some of them. This seems to be the thing that you've been known for. Explain this to someone who has not seen one of this videos. And tell me why you take your clothes off to teach mathematics.

TC: The concept is equations stripped.

BH: Right.

TC: And I present a famous equation and I strip the equation back.

BH: Yeah.

TC: Layer by layer. So making it more and more understandable.

BH: Okay.

TC: So we start with just like what is it, where does it come from. Maybe a little bit about what the symbols mean, maybe a little bit more like can we do cool stuff with it. And I was like I'm stripping back the equation... I decided [laughs] it would be hopefully reasonably funny if I just suddenly had less and less clothes on.

BH: Right.

TC: So as I say in the video I'm stripping back to layer two and I just casually

reappear on camera. There's no actual stripping because that would be awkward for everybody. [laughs]

BH: Right.

TC: But I just you know we cut and then I come back in and say stripping back to layer two and I happen to have one less layer of clothing on.

BH: Yeah. You end up with not a lot of clothes on.

TC: I end up in my pants, yeah, in my boxer shorts, yeah and I always... I plan these things so that I wear the right number of layers at the beginning so that I end up in my underwear. [chuckles]

BH: [laughs]

TC: And there's these two reasons behind this so I was kind of influenced for when I was at the Naked Scientists. So they were started around the same time as like Jamie Oliver, was the Naked Chef, and like from what I remember he didn't ever cook naked.

BH: No. [laughs]

TC: [laughs] I was gonna say I don't remember that being on TV.

BH: That was just 'cause it's all about raw ingredients and stuff.

TC: And that I think was the idea with the Naked Scientists. Stripping science back to the basics. 'Cause it was taking research but explain it for everybody.

BH: Hmm.

TC: And I felt that we should have had more fun with that because we were a radio show so no one could see.

BH: Yeah.

TC: So I was like all about the innuendos when I was writing scripts. I was all about making comments about oh it's a bit chilly in here today. Even though I'm sat there fully clothed, probably with a hat on or something, but I'm like... so I tried to have a bit of a laugh with it because I think a lot of our listeners and when we had guests they would make that kind of joke, about oh I hope I don't have to turn up naked and so I think people were already kind of making that association. I think I was probably maybe too keen [laughs] but I think that kind of put the idea in my head being about this is quite fun let's like riff off this. And then the other thing was when I started doing the Youtube and things, I wanted to find out what kind of place I was filling in the market almost.

BH: Hmm.

TC: So I wasn't just like, am I just gonna make other maths videos? Well, you know, Numberphile already does that really well! So like [chuckles] what can I bring that's a bit... especially when you're starting out I think you need something.

BH: Hmm.

TC: And the thing that I thought was well I'm up for doing the naked thing and it also... from talking to lots of people who didn't engage with maths, so like friends, family, et cetera. Something that came back to me that surprised me was they said it's a very serious subject. For me as a mathematician I now completely understand but me at the time I was like... is it? 'Cause I'd never thought of that, but for people outside of maths I can definitely see why you would see it as serious. It follows a set of very strict rules and everything's like in order and

correct and there's not... it feels like there's not much creativity. There actually is but to an outsider I can understand why it might look very serious and to me the easiest way to make something not serious is [laughs] to actually do it in my pants. When I'm stood here telling you about Navier-Stokes in my underwear, you can't possibly take it serious. You might not want to watch the video [laughs] you might not pay any attention whatever but you definitely can't see it as serious and I felt like that was an important thing to try and get across as well.

BH: Do you think you would have gone down this path if you weren't like a super fit guy who runs and lift weights and doesn't eat bread and stuff like that? like [laughs]...

TC: Well, funny story about that. So I've always been... played football all my life, still do, still play with my students actually now. I'm still just about at thirty-one I can just about still play with the eighteen year old [laughs] players. When I decided I wanted to do this, I actually got in touch with a few of my mates who go to the gym and they created me a training plan, 'cause I was like... [laughs] 'cause I was skinny, you know? I looked like kind of like long distance runner skinny.

BH: Okay.

TC: Like four or five years ago. And so I decided, if I'm gonna do this I'm gonna do this properly. I'm gonna start doing weights, I'm gonna start going to the gym and I'm gonna... at the beginning especially when sometimes I couldn't be bothered with it everyday or whatever, I saw it as part of my job. I was like, this is actually me just the same as recording and editing a Youtube video.

BH: Or like a movie star that has to get in shape for their part, okay.

TC: Yeah! [laughs] And that helped me to actually stick up with the routine, I think.

BH: I don't know your parents but from how the little bit you've explained them to me, they seem like practical people, you know, they went into jobs. They didn't go to university, you said, you think partly because they wanted to earn money and start a living and they've always seemed to have wanted the best for you. What do they think of your path and in particular what do they think of the naked Youtube videos? Is this what they wanted for their son? [chuckles]

TC: [laughs] Well I don't think anyone wants their [laughs] child to be naked on the internet.

BH: Right [laughs]

TC: So [laughs] let me put it that way.

BH: Yeah.

TC: No obviously at first they were like... you know they were a bit like, are you really gonna do this Tom. Is this... are you sure? And I'm just like, yeah. But I think by this point, you know, I was when I started what maybe... twenty-seven or something like. I think they realized it just did fit with my personality. Whenever we'd have fancy dress parties and things, I'd always be the guy in body paint and whatever. I was just generally... I wouldn't say like, you know, enjoy being naked but I just never really thought much of it, you know? Some people really don't like that and I'm just kind of like whatever. Everyone looks the same. Like kind of, I dunno, quite chill about that whole thing, and I think that kind of also obviously meant the fact that I was open to doing this in the first place.

BH: Yeah.

TC: But yeah no... at first my dad in particular [laughs] was quite going like

you know [grunts] what are you doing to like kind of like... no son of mine kind of vibe.

BH: [laughs] I was so proud when you got into Oxford!

TC: [laughs]

BH: And now look! [laughs]

TC: Yeah. But to be... both of them now are so like... so supportive and like you know even one thing that really got me was quite early on actually, one of the early videos I made, like my dad just saying... just one day when I came home just being like, oh I watched it actually and it's really good. And just like that 'cause he is not the kind of person who'd ever been on Youtube.

BH: Yeah.

TC: And you know it was quite a touching moment that he'd actually gone out and thought, you know if this is what my son's doing [laughs] like agree or disagree this is what he's decided he's gonna do, I'm gonna, you know, watch some of these videos. And every now... sometimes you know he'll just message and be like oh I really enjoyed your video this week. And it's still sort of... 'cause he's very much not that person.

BH: Hmm.

TC: So like I think that's really cool. So I think they're both super super supportive. They obviously think it's ridiculous. And they always give me like sort of quips and comments and being like when are you gonna get a real job. When are you gonna grow up? But I think they can see that I'm enjoying what I'm doing and so they're like, you know, I'm doing alright so they're just like cool. Go with it.

[gentle piano music]

BH: How do you enjoy the teaching side of things? Does that become a grind? Does that become a chore? I speak to some academics who love their research and for them teaching is a chore. Something they have to do to... it's the pound of flesh they have to give to be allowed to be a researcher. But you've kind of embraced it.

TC: So that's a really common view, actually. You mentioned about some of the best mathematicians or other scientists [chuckles] like the teaching they're like, oh I gotta teach today. I definitely have days when you know maybe I've gotta do a nine AM lecture [laughs] and I'm like, you know, go to be at two do I really have to get up infive hours and go and give this lecture. But in general I absolutely love it. It's just kind of an extension of doing Youtube to me. It's this...

BH: Performing?

TC: Yeah it's just performing. It's... I happen to, you know, have learnt this stuff myself. I happen to have the knowledge of this maths. How can I explain it so that the students understand it? Can I make it entertaining? I think I did this anyway, 'cause I did a lot of teaching during my PhD to earn extra money. And I think even then before I was like performing on Youtube, I always tried to make it entertaining. Because I felt like people are just more interested and enjoy it and remember it more if it's entertaining. It just makes it more engaging. And so I've always tried to do that when I teach and I think that's sort of yeah so I now just sort of see it as like an extension of doing a Youtube video. Except it's just, you know, me and my two students in our little Oxford tutorial for an hour each week.

BH: Do you think... I mean I know this is asking you to make a huge generalization... but what is teaching like, like at places like Oxford? Is the

teaching... do you think enough attention is paid to the teaching? Like you know you're obviously try to do things in different ways. Are all the teachers here trying to do things in different ways? I don't know.

TC: It's not a particularly insightful answer but I think it's... you get a bit of everything. I've got colleagues and other people I know in the department who are very keen on trying out new things. Who in particular with, you know, have very been keen in adapting new things for remote learning. Whereas I've got others who are just very much doing what they did before but now it just happens to be to a camera, rather than in person. So there's like a range of, you know, some people are experimenting, trying new things. I actually did a part-time teaching qualification a couple of years ago with other colleagues at university. There was about thirty of us doing this. And that was looking at the scientific evidence behind teaching. And that was really interesting. 'Cause it was... you know my background as like mathematician scientist was using the scientific method to teach things. So try out this method, this style of teaching, does it work? Get data, refine. I found that really really helpful. And again so you know there were another twenty-nine people on that course who were giving this... this was, you know, in your free time. To learn about this, so obviously there are lots of other people who clearly care about helping their students learn in the most efficient way. But then at the same time as you sort of said with previous guests you have people who just kinda wanna focus on their research but they know that they have to do a bit of teaching to sort of keep the university happy.

BH: Hmm.

TC: And I think that system in general is actually wrong. And this is something I found when I was trying to apply for positions a few years ago earlier on my career. Because when I was applying for a teaching only position in the job description, not everywhere, but in the job description of some of the Oxford colleges, it would say you need a strong research profile. And I do not

understand why you need to be really good at research if all you're doing is teaching. Surely you just want to be really good at teaching and if you happen to be good at research that's a bonus. I can appreciate why it is a bonus but it seemed odd to me that it was a prerequisite. You had to have a strong research profile for a purely teaching position. So I think the best way to do would be just separate them. I'm aware possibly I'm in the minority as someone who just wants to teach, but have people who have that passion and that desire and that hopefully are good at teaching, have them do the teaching and then have the people who are awesome at research have them do the research.

BH: Of course this is because universities get money from the government based on how good their research is not how good their teaching is. [chuckles]

TC: I'm... I'm... yeah.

BH: [laughs]

TC: So it just seems very odd to me.

BH: Hmm.

TC: To sort of force people to do things that they don't want to do when... so I can see maybe in the past why it happened and then I can see the draw of it 'cause I know that some students might apply to a certain university or within Oxford to a certain college to be taught by this specific person.

BH: Hmm.

TC: 'Cause they want interaction like I was lectured by Sir Andrew Wiles for example or something. But... at the same time so I can see like why it overlaps and maybe in the past nobody wanted to teach. So you kind [laughs] had to say right well if we all do a little bit, you know, c'mon everyone if all just do a tiny

bit...

BH: Yeah.

TC: We'll kind of cover it. But I think now it seems... I'd like to think there is a bit more of a shift, we'll see. I think it's maybe starting to turn towards this idea that, why not have specialist teachers. They still know the maths they need to know and they are gonna really teach the students well. And then when you start progressing to graduate level when you're doing research that's when you need to interact with the actual research mathematicians. But I think for undergraduate degrees in particular, just for me just have the best teachers. As long as they know their stuff and can teach, like that's just the perfect way to do it.

BH: So you're now in the first year of this three year fellowship, so there is a... it's still a way away but there's a clock that's ticking... what do you want to do next? What's... is there a next step? Is there an endgame? What do you want to be doing in ten years?

TC: [laughs] Umm...

BH: Will you be wearing clothes?

TC: [laughs] obviously not! [laughs] Well I mean obviously there's a shelf-life to the naked mathematician. I don't think anyone wants to see a seventy year old man in his underwear.

BH: [laughs]

TC: Talking about Navier-Stokes. [laughs] So there's that aspect. But no I think I'm really really enjoying what I do now.

BH: Hmm.

TC: So this year in particular even with all the challenges of the current situation this year in particular for me it's felt really nice to have that additional time to really focus on Tom Rocks Maths and Youtube and everything else. I've really been able to commit to that and I'm enjoying that a lot. So I'd like to keep doing that, I'd like to keep sort of doing more Numberphile videos [laughs] stuff like this. I love it, I love talking maths. I just it's what you know it's what keeps me going. It gives me my energy I think. It feels like I just started this on you know the last year before that was kind of spent trying to put all of this brand new position together. 'Cause that required a quite a decent chunk of work to figure it all out.

BH: Hmm.

TC: We had to get some funding and there was like a whole thing to put this all together. So I don't think I've thought too much about it but if I'm still doing what I'm doing now in 10 years I think I would be more than happy.

BH: Alright. Cool. And how's Manchester United looking at the moment?

TC: [laughs] Uh... we'll we're currently ahead of Liverpool the league.

BH: [disappointed sigh]

TC: Which is always nice.

BH: Let me ask you this then, and one last question. Would you... hand back your PhD and sacrifice all your mathematical career... to be a Manchester United player?

TC: [sighs] Oh that's a question. Umm... [sighs] probably. [laughs]

BH: [laughs] Thank you for being so honest.

TC: Yeah, I love football.

BH: Yeah [laughs].

TC: I watch it. As I said I still play, I watch it, you know, any game that's on. I... yeah no I probably would. Yeah... if that was the deal, give up your PhD and your maths knowledge but I'd playing for Man United.... yeah yeah I think I would. Yeah.

[Gentle music fades in]

BH: That's all for today. You can find out more about Tom via some links I've included in the notes for this episode. It'll include a list of all his videos on Numberphile, in which I can assure you he is fully clothed. Thanks to G-Research for supporting this episode, see their link in the notes as well and thank you to the Mathematical Sciences Research Institute for their help. I'm Brady Haran and you've been listening to the Numberphile podcast.

[Gentle music fades out]