

# Transcript

## Digging for the Why – Season 2

### Episode 1 – Communicating Maths Effectively with Ben Sparks

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Special Guest: Ben Sparks

**Andy: 0:15**

Hello and welcome to this episode of season two of Digging for the Why, the podcast for maths teachers where we explore the thoughts behind asking why. I'm Andy, one of your hosts, and as usual, I'm joined in the virtual education world by Alison. How are you this morning, Alison?

**Alison: 0:28**

I'm very well, Andy, thank you very much.

**Andy: 0:30**

I was going to make a play on Oasis Education there from Ready Player One, but then I realized that there are loads of schools in this country that are in Oasis Education, MATS and stuff. And I didn't want them to think we were singling them out. So I didn't say it, but equally, I have just said it. So there you go. Anyway, we're not in Ready Player One. We should be. The world would be a much more exciting place.

For today's episode, we are joined by a mathematician, a musician, and a public speaker. No, no, no, no, not three people. Just one superhuman who manages to juggle all three different bits of his life. And as we've just learned off-camera, off-recording, all parenting is thrown in there as well.

So today we welcome Ben Sparks into the maths pod-land. Ben is the aforementioned mathematician, musician, and public speaker. He gives math talks and workshops around the world to students, teachers, and the general public. He's a little bit freelance and a little bit part-time with the AMSP, and he's based out of the University of Bath. You may know him from his work with 'Numberphile' on YouTube. He also has his own YouTube channel, which is called Sparks Maths.

Now, I first came across Ben years ago when I was teaching. We used to go to the math inspiration lectures run by Rob Easterway and Stand Up Math's Matt Parker. And they're brilliant. And I saw Ben several times and he always had his guitar and, and me being a guitarist as well. It's just amazing to see him on stage. So, it's great to have him here. Welcome today to Digging for the Why. Ben, how are you?

**Ben: 1:53**

Thank you very much. I am, I am well, although I'm not either three people or a superhuman just to get it out there. I'm definitely a human struggling to juggle all three rather than some sort of like 'superhuman'.

**Andy: 2:05**

Sounds very familiar. Very familiar adulting. I like to call it. Yeah, exactly. So, as you guys know that are listening, we've changed season two up a little bit and this year is about just trying to discuss some kind of common questions with our guests about digging for the why and where

they've come across this idea of asking why in their careers and lives and, and what's brought them here and why they've done it. Potentially regretfully agreed to come on the podcast and talk to us. So the first one is a kind of common question that we're asking people, Ben, and in the last couple of weeks, what's happened to you to make you ask why?

**Ben: 2:44**

It's a good opening question though, isn't it? Cause it's nicely specific instead of trying to put big picture ideas out there. I was like, right, when did I ask why recently? In the last week to really narrow it down, I was at a conference called Communicating Maths for the Public, run by the Isaac Newton Institute in Cambridge, and the whole conference was about communicating maths, obviously, for the public in the sense of public sector mathematics communications to governments to regulatory authorities as well as people who are kind of popularizing and enrichment maths and so I've been asking this week a lot of why do we talk about maths to anybody let alone teach it? Why does the government need to know a bunch of maths? Why do statistical authorities try and tell the government a bunch of maths and how do they do that in a way that people understand it?

So, it feels a bit like it's been a bit of a meta week because why do we do the jobs we do as a teacher? Why is this subject important? Isn't it? I've been thinking a lot about why people do not hear it. Why do people not listen? Even if you give them good mathematical advice or teach them good tools to use. So, there's, there's a big meta communication questions rather than just why this maths exists. I don't know if that answers your question, but are you happy with that?

**Andy: 3:54**

Oh, absolutely. Like it's just, it's. When we were, you know, before, when we were planning kind of this season, we're thinking of what questions to ask. Cause last year we were a lot more focused on very specific things with each guest. You know, they were in on the podcast for a reason. And this year we wanted to open it up to people just in the maths world. So, we were like, well, let's just ask them, you know, what's made them ask why? Because everyone that's coming on. Is it with the reason that we've chosen people that we would like to come on the podcast is that we know they do have this thing about asking why, so, think of described scratches, superhuman with all the different things that you do. And you know, what, why do you do what you do now, what's the journey been like for you to get to being public speaker, doing work for universities, talking at conferences, things like that, what's led you to that and how has, 'why' influenced your career as a word and as a kind of question?

**Ben: 4:46**

Why are you what you are? Is that what you're saying?

**Andy: 4:49**

I mean, it's a bit deep for a mathematician on a Friday morning, but you know.

**Ben: 4:52**

Well, it's interesting when people ask you about your job, you know, maybe the typical taxicab conversation is like, oh, so what do you do if you're on a longer than expected taxi journey? And I've resorted now to just saying I'm a maths teacher, which is not accurate, but it's an easier thing to explain to say a taxi driver than this sort of ins and outs, but I do genuinely think of myself more in that light, there's nothing else that as a math teacher, I did 10 years teaching secondary maths in schools alongside some other stuff by the end. But that's where my sort of passion lies is communicating, but I've got enough of an egotistical streak that it becomes a little bit 'performancy' as well, and that's kind of what I've ended up doing, but why do I do? I like, I like the pedagogical experience of taking people through interesting ideas. That, that, I mean, it's, That's the short story.

The long story is that I taught Maths for a long time, and it's hard, as a lot of people listening know, and teaching Maths is busy. And I increasingly tried to do some other stuff that I really enjoyed,

which is this performance y stuff, on the side when I first got an opportunity to do it. So it was way back when the AMSP didn't exist, it was called the Further Maths Network. 2005 or 6, I think we're at now, and A colleague and friend, in fact, ex-teacher of mine from school days, I was working at the school where I went to school, bizarrely. It happened to be the Further Maths Centre for the area, and Jo Sibley, who still works for MEI, was organising a maths outreach conference, and she said, To this young, newly qualified teacher at her school come and do a workshop. So I wrote a talk or a workshop and I've been using sort of the bare bones of that talk and workshop ever since.

So that's, you know, it's getting on for 18 years ago. I think it's a little bit frightening. It has changed somewhat that workshop. I hasten to add that if you look at the original slides I wrote, I, well, I should burn them before anyone else sees them, but that was a starting point. I realized that I can tell people's stories about mathematics That may be worth telling even if the details are not going to be on the exam. And that's been a bit of a recurring theme for me is that I feel very lucky to be someone who gets to talk about bits of my subject because they're worth talking about and not just because someone else has decreed that this is going to be part of an assessment. I'm not anti-assessment. I think we should assess things and that determines a lot of what people see as valuable, but there are things which will never be assessed that are still worth discussing. And I don't think any teacher will blame me for enjoying that aspect of my role now. I get to get to choose the bits to talk about which feel like they're worth talking about, even if no one else was going to tell me to. I don't know if you want one more detail about the journey, but that's the sort of motivating thing behind it.

**Andy: 7:31**

No, I like, I like that. We, we used to have, um, what did we call them? I can't remember. Oh, like a carousel basically of non-curriculum lessons for year seven. And you would, you would devise something and take it round. And over the year, every year seven class would experience all four of the different kinds of lessons or experiences, whatever it might've been. I was going to say lectures, but it certainly wasn't a lecture. And it was great because the kind of the brief was this cannot be on the year seven curriculum. Can't really be in key stage three, but it needs to be linked to maths. Yeah. And it was like, okay, that's kind of cool. And then, and I think I've mentioned it before in this podcast I did. Like combinatoric stuff about going to cinema sitting in different orders And then linked it to premier league fixtures And how does the fixture machine work and how we have algorithms but we have to put rules in place so that things don't you know You don't play the same team twice and all this kind of stuff and just to try and get the kids recognizing that You know maths is throughout and then it was that kind of lessons. Those sessions were great to generate like But Mr Lumley, why, why does this happen or why does this happen? All they'd sit there and go, Oh, so is that why it's always home and then away at the start of the season? And you'd be like, yeah, that's, you know, that's what they do. And this is how it all works. And if you just left it completely random, well, it wouldn't be random. And then I bring out.

One of my favourite random quotes ever of Steve Jobs talking about the iPod and how people complained that the same track would attract from the same artist would play twice in a row. And he said, so we had to, you know, when you press random, it's not random guys, because we've had to cheat the code and cheat it because you don't actually want random because people don't get what random really means, you know,

**Ben: 9:17**

to be less random, to feel more random.

**Andy: 9:19**

Exactly. And it's that kind of thing and anything like that, which can inspire kids to just think about. The maths that they're learning or the life that they're living or the things that they come across and, and do that, you know, so no, I, I, as a, you know, a former teacher, I appreciate that. Like you said, there isn't that time in the classroom to do all those things that you want to do.

**Ben: 9:40**

And that's a hard sort of fact of the world of teaching.

**Andy: 9:45** And that's, you know, from our secondary experience. And I guess we've talked about it before, but similarities in the primary sector, right?

**Alison: 9:51** Yeah, absolutely. And I was talking to with, working with a group of teachers on Wednesday, from 5 to 8, actually going back to what we talked about last time. But they were sort of, there was this, they're driven by the curriculum. They're driven by getting kids to the right place at the end of year 6 and getting kids to the right place at the end of year 11. And I think for, when I was in the classroom, I used to, To try to, within that remit of we've got to get over this, these bits of the curriculum so that you're able to sit in that room in May and not feel completely lost, but to, to try to paint sort of broader brush strokes across the curriculum. I think that's what we came down to talking about on Wednesday with this group of teachers and saying, you know, If we're teaching an understanding of multiplication, you know, how many different things can we hook onto that understanding and I was going around my head today has been an idea of a calculation and thinking of all the problems that maths problems, that very simple division calculation might be solving, and it could be something to do with percentages. It could have something to do with ratio. It could be a direct proportion and scaling problem. All of which can be quite compartmentalized. And I think I, we used to do similar things on these carousel days where we'd, we'd say, go and do something fun. And you think, well, hang on a minute, it should all have an element of fun. I know fun isn't the key thing, but if we're not leaving maths lessons with a sense of, oh, that was interesting. Oh yeah. Quite enjoyed doing it. Oh, I never realized that connected with that.

**Ben: 11:19** It is important, isn't it? Oh, she's gone. We will carry on. She will come back. Too profound for the podcast to cope with it. I was going to comment that the. The idea of fun like let's do some fun things as opposed to the normal things. Like every teacher has a sort of slight ambivalent reaction to that, I think, because yes, we want to make it fun, but that, like, is it not fun to learn just stuff anyway? But the serious comment, I think, is that nobody, kids or adults does anything without some motivation. And pretending they do is just completely false, but the motivation could be someone's threatening you because you must do this or else. You must do this to pass this exam, or you want to do this because you want to do this. And, like, choosing to do a chore, for example, might be because your life would be worse if you didn't do the chore but choosing to watch TV or watch a film is because you want to. And choosing to study maths, like, anytime it ever happens is because someone has some motivation, which could be the teacher inflicting their will or reminding them there's an exam. Or it could be that they want to study it, or some probable combination of all of these subtle things. But I think paying attention to that as teachers is always important, and occasionally trying to mix up the motivations that are available helps.

So, exams are important, and wanting to do well because there's an assessment coming is not a silly idea. But if that's the only reason you ever study a subject, it will feel different from whether, from all my, you choose to study it because you're just really, really fascinated by that particular picture. And, I guess, the educational vocab out there is extrinsic and intrinsic motivation. Does the task you're asking someone to do. Or the task you're doing yourself motivates you in itself. That'd be the intrinsic idea, or is something from outside making you want to do it? It could be a threat, do it or else, or it could be a bribe, do it. And you'll get a sweet, like those, those methods work, but if that's mixing it up is really helpful and it's not just about teaching. This is about any of us doing anything, thinking about why we do it. It's quite insightful to realize how you get other people to do it or how you share things that need sharing.

**Andy: 13:23** Okay. So I'm going to ask you about blending kind of bits of your role together. So I've, I've seen you at maths inspiration. So when you're, when you're planning a session for maths inspiration, you're, I guess, providing some kind of external motivation to hopefully feed into an internal motivation for the students to go, Ooh, this has caught me here, you know. And I, I've

brought different schools to those lectures, and I've brought different levels of students and students who are doing maths because they absolutely love it, everything about it. They want to know more. They want to read books about it. To the student who's gone, I've got to do maths because, You know? And it's like, okay, and they're all coming, and it's like, we're going to these lectures, or why do you have to go to a lecture about maths when I, you know, as in fellow maths teachers are all going, it's really good. And they're going, you're a maths teacher. Of course, you think it's good. Of course, you think it's entertaining. It's like, no, trust us. And then it's getting them there. And then they have these sessions, whether it's you, whether it's Rob, one of Rob's sessions whether it's Hannah doing one of hers and you just watch these things and the kids come away infused by it, so how do you figure out what your session is going to be? How's the structure going to be? And how does that compare to delivering a session at university? You know how if you're in a classroom? Yeah, Like, how can you apply similar things where you just want the students to leave with enthusiasm and curiosity? Whether that is a lecture, whether that is a session like that, whether it's a lesson in school, you know, It's a big question.

**Ben: 14:51** What are the similarities? I think it's a trade secret. Does that, does that short answer? I'm not, I'm not telling you, no, that's unhelpful.

**Andy: 14:58** Thank you, Ben, for coming on the podcast today.

**Ben: 14:59** I, like any teacher, lecturer or presenter. This is hard. It's a subtle thing. But let me try and get my thoughts in order here. It's perfectly possible for a maths inspiration talk, which for context, if anyone's not seen it, is usually in a theatre rather than a classroom, with between 500 and a thousand in the audience on a stage. Lighting and music and things. It's not some sort of a rock star show, but it's also not a classroom. And that's quite important. So first of all, the atmosphere is not one of here's a revision session. They're also not on home territory. They've gone, it's an event, it's a visit, it's a trip. And that is really significant because I think it changes the atmosphere. Even if, as you point out, the expectations of, we're going to a maths lecture doesn't necessarily they don't know what to expect, but already if they're in a theatre and there's background music, that's not awful, and the lighting is sensible and the projector works, these things, these things are important. And without those things, the atmosphere would be much more like we're in a sort of tired classroom or assembly hall. So, although I don't like that it feels superficial, it is important and pretending it's not. Realizing the lighting's broken you say, Oh, it doesn't really matter. It does matter. But once you've got that, then you are in a position where the students are a bit more like, Oh, this is an event, but it does need to feel professional. I guess this is what I'm really saying here. At that point though, it's perfectly possible to present some content to them. As long as it's delivered carefully, you know, with performance technique, that's not terrible.

You can deliver them academic content. You can tell them how to solve an equation from a stage if you're careful about it. But you can also, I think. More easily because of the atmosphere created. You can just show them which something is worth showing them. And you can say, look, let's just do this because it's nice. And so designing a session for maths inspiration is. In some sense it's very like designing a classroom session. You figure out what you want to tell them, and you figure out why, and you figure out who the audience is, and how to get those ideas across. And if you don't ask those questions, you're asking for trouble. It might work anyway, but likely not. But in this case, the audience is teenagers; they're there on a school trip, there's a bit of atmosphere, you have a little bit more permission to show some spectacle, and that's when you should show them some spectacle. Like you should wheel out the big punchlines, or the, the sort of, the high points. Because that's the things we don't always have time to deliver in the classroom, let alone prepare to do. So maybe Maths Inspiration has a responsibility to show the greatest hits.

What's the, there's a Maths Petitioners Lament by Paul Lockhart, I think. I forgot, I didn't. Look up the details. This famous essay is about how maths feels, maybe from outsiders. It's like if all you ever teach is the techniques of mathematics, it's like teaching someone to paint, but all they ever

do is paint fences. Like, fine, but maybe you should take them to the Louvre. Like, show them the greatest hits. Show them the great works. And then, that is as true in mathematics as it is in painting. But when did we have time to show the great works of mathematics in the classroom? Yes. If you're a mathematician and you're aware of them, you want to, it's hard to find time. Maths Inspiration maybe should take that role or things like it. So that's, that's the first thing, try and find the things that, right, we can show them here in an atmosphere which wasn't available, wasn't as easy to provide in a classroom, so that's important. But then, in my situation I'm, I'm not on the maths inspiration, maths inspiration list because I, like, I'm an engineer who built a bridge to space. If I was, I'd be there to talk about that.

So Paul Shepard, for example, is an engineer at the University of Bath and talks to them about designing all sorts of shapes for stadiums he's worked on. Yeah, I've seen that talk, it's unbelievably interesting. But he's got a very focused reason to do what he does. And I feel a bit like, oh, it's nice to have less of the obvious topic to talk about, but also harder because then you have to choose what to talk about. And in the ones you may have seen me talk about, I've ended up Framing it all in the context of a song, which is completely and utterly shameless. Like I don't get to play in public unless I make it happen, but I play the guitar, and I sing, but I'm not a very good parody comedy maths musician. I can't play a funny song with some maths lyrics. Other people can and really, really well. Kyle Evans, for example. excellent musician, also funnier than me, and makes sort of fun maths songs out of it. Whereas in my context, I wanted to pick up on the idea that music has this sort of rationale behind it, which we don't question. We do it because we like it. We do it because it's nice. There's no reason why we feel like music has to be useful, and no one really is worried about that. But we also do maths for the same reason. It's just that everyone's also saying, yeah, what is, what's it for? So, by putting a piece of music, unashamedly, which is just a piece of music, which I like, you get to talk about maths being like that. I also then end up choosing bits of music which have lyrics which, Mention things I want to talk about. And then it provides a sort of artificial framework to hang a talk about. And any good presentation needs some sort of structure.

The first one I wrote for Maths Inspiration with Rob was based on the song, The Shape of My Heart, by Sting, which is about a poker player. One of the verses talks about the sacred geometry of chance and the hidden law of probable outcomes, numbers leading a dance. Literally all I did was take that verse and put each line as the title of one segment of the talk. And then suddenly we've got a structure and I get to show some really nice bits of maths that also kind of get drawn together by the song at the end. And then, you play it and sing the song at the end, which is always potentially David Brent's level shameful moment. But I think there's something to be said. It's like, if you're making a spectacle of it. And then you actually go through with something which has got a little bit of jeopardy about it. A live piece of music. Live music's interesting because there's jeopardy. That's at least partly why live things are interesting. What if it doesn't work? Like, there's no, there's no fallback position. That makes everyone sit on their seats, do magic tricks, and gamble. Music, there's something about that vision of, ooh, is this going to work? And if you're not awful, then you come across looking quite good. So who knows? I have been awful at music on stage before now, but if you're not awful, then that's a nice way of celebrating the spectacle. There's a slightly rambling answer there.

**Andy: 21:21** All right. So how often does the guitar come out in the lecture theatre at Bath?

**Ben: 21:24** Very rarely, actually when my, it's very confusing figuring out who I work for these days. I do, I'm employed by the University of Bath, but only because the AMSP gives the money to employ. So I worked for the advanced maths support program, and I happened to be funded via the University of Bath, but then occasionally, the University of Bath asked me to do some things for them. And so I do teach one course at the University of Bath, but it's not a maths module; it's a maths communication module. It's for third-year undergrads. Who has chosen to do a half-year

module on how to talk about maths or how to present math or how to write about maths, which I think is actually a really interesting course? It's very unusual. There's one other course in the country. I think that does it on a maths degree. I think there are more coming. Chris Bud set this up many, many years ago and has been running it for a long time, but it's. I haven't played my guitar at them. I have pointed out that I use music in maths communication, but the poor sods on this course don't very often have to put up with me actually playing at them. Probably much to their relief.

**Andy: 22:24** So, assuming that's more of a lecture style of a session kind of thing, how are you planning those sessions to, again, enthuse them? Like you say, you know, I Do

**Ben: 22:37** you mean these University maths communication course sessions?

**Andy: 22:39** Yeah. So I, I've, you know, whenever I've gone to maths Inspiration, it's at the RNCM in Manchester. Those lecture theatres are set up for sound. They're set up for music. That's the whole point of the, you know, the Royal Northern. So that's like, say you can provide the wonder, the spectacle, and you know, as long as it's kind of, you play it properly and you don't mess your chords up and you have words and all that kind of stuff, then it's going to, kids are going to go, cool, you know, and even if you do mess it up a little bit, they're going to go, this is fun. So then you're in a lecture theatre, I assume, and you're delivering a session to third-year undergrads. How are you going to apply some principles from your spectacular lectures to a less spectacular, I would assume? Yeah,

**Ben: 23:22** particularly because it's a bit meta, because I'm trying to explain to them how to judge Spectacle and how to design this, pretty much what you're asking now. So it's very meta, but there are a few principles which are going to sound pretty cliché, but things like show don't tell, like you can, you can tell people about stuff, but if you have an option to show them the stuff that you're telling them about as well, or instead of. You should probably do it. And there's an extreme example of this, but in the course at the University of Bath for these students, it's actually surprisingly hard to get that in action because you're stuck in a lecture theatre, and it isn't a spectacle thing but YouTube exists. And so there are videos of good things, and that's quite now a really important part of the course, you can show other people who've done something on video. And in fact, for that course, we asked them to. Make a piece of content. So it might be a video or write an article so that they can recreate some of that.

Actually, I'll say a bit about the course. They have to deliver something live. We usually use the Royal Institution masterclasses around the country, and they go off in groups as undergraduates to deliver one of those. If you don't know about the masterclasses, Saturday morning, a couple of hours. self-selecting audience, usually of year eights or nines or tens, really interesting context to learn how to present very different from maths inspiration, but also very different from a classroom and watching them go and design a session and then mess it up. Cause that's how you learn stuff is important. Like they've got to have a chance at trying it. And that's what I think the value of that module is. We then also get them to create some content, maybe a video, maybe an article, maybe a school placement, which is a very different thing, but Then they get a chance to make those things.

However, coming back to the other like, you can tell them all these things about good advice, but unless you actually do it, that was my first point, it's very hard to learn this stuff. So the main value of that course is they have a chance to do stuff. And as we always point out, to mess it up and reflect on it, which is like the big skill for all of us, teachers, presenters, anything, you've got to do something and reflect. Otherwise, it won't get better. And so we try and get them to do something. And that, in that case, show, don't tell, like we tell them what to do, give them some advice and then they go and do it and like, okay, right now, you know how it feels, but in a slightly different aspect to that, the show don't tell advice in terms of making a spectacle. Or learning how to, to sort of reinforce your point.

There's a good thing, which I've seen Matt Parker do very well. And I've tried to do it as well, but is this, if you have an idea which you want to tell someone about because it's exciting and you tell them details, then you should consider actually showing them the thing instead of just telling them about it. And that's the show don't tell, but you should also look out for moments where you say in your head, someone's explained a thing that you're like, would that actually work? Could we actually do that? Particularly if it's an extreme idea. Because then if you're in the position of planning a spectacle moment, which is less of the run-of-the-mill everyday thing, like you're going to make a high point here, that's the time then you actually do it if you can.

And so Matt Parker, for example, let's say he was looking at the idea that you can make a Menger sponge, which is a fractal, a cube with a whole drill through every sort of dimension and then all the way down. So you've got a fractal structure, really nice mathematical object. And like, well, could you make one? No, because it's a fractal structure and it's infinitely. Holy, but can you build a model out of a card? Yes, you can. It turns out you can build them out of business card things. You make little cubes, and you slot them together. And then, then you look at, well, how big can you make it to simulate the fractal? And so Matt was like, well. Can we break the record of how big you can build this? And so, you actually build it.

There was a project now getting on for eight, nine years ago, 2014, I think it was, the Mega Menga. And so around the world, people were building Menga sponges out of business cards over a million business cards around the world built into this huge sort of level four fractal. And it has that sense of spectacle because someone who's got the decision to make it like, could we actually do this? Yes. Let's make it happen. That's a big deal, that it makes it a memorable thing, and it's not something you can do on a day-to-day basis, but you look out for the opportunities where you can actually do it.

But it works on a smaller scale too. I'm going on about it now because I'm getting excited, but the other extreme, this still works. So, I saw a really good example of a friend and colleague of mine who also works for Maths Inspiration from time to time. I was chatting to him this morning about an engineering project called Hugh Hunt. He's an engineer at Cambridge. He does good talks about spinning things, boomerangs and gyroscopes. But he got invited on the great British menu TV show where they're cooking stuff, right? But then this series was celebrating great inventors. And he got invited as a guest judge to talk about inventions and taste some food. But Hugh, in his irrepressible style, couldn't resist doing some demos. So, there's a one-minute clip of him talking to the other guests and celebrity judges about why toast falls butter-side down when you drop it off the table. Absolute classic case study of a piece of cliché mathematics slash physics. But in this one minute, he does a really good example of telling the details, explaining some of the maths, but choosing whether to skip the gory detail. You've got a minute; you skip the gory detail at that point. But explaining that it lands butterside down because of a coincidence of gravity, time from a tabletop to the floor, and the amount of rotation it gets when it falls off. But then he says this lovely thing, it's like, of course, if the table was a lot higher, like four times higher, then it would have more time and therefore would land probably butter side up. And in that heartbeat when he says that what I think is happening is the entire audience, including the judges in the room, are like, really? I want to see that. And then the heartbeat passes on, and they've done a really nice edit, and you see Hugh standing on the table, also on a chair, to hold the toast four times higher than it was and pushing it off a plate. And lo and behold, it does a double flip, lands butterflies up, everyone cheers, and we've made a spectacle out of something, but it's a little tiny picture of what mathematical models do. They make predictions. And then you kind of forget that sometimes you need to say, wait, let's see if it actually works.

That's a really lovely part of a pedagogical cycle that we quite often miss is like, does it actually work? Can you do a sort of artificial or contrived version of actually trying it and making a spectacle out of it? It's a good habit. If you ever think, is it actually going to work? To think about whether you could make it work.



**Alison: 29:18**

I think that touched on too. I grinned when you said Hugh because I just pulled up something that went back to seeing the greatest hits that Hugh wrote for an MEI publication a few years ago, which I'll come back to. But I think what a frustration for a lot of teachers at the moment is goes back to what I was talking about, this drive through the curriculum, very tight planning is that we're missing teachers asking those questions that perhaps through the Maths Inspiration Lectures, there's the opportunity in the planning to ask those questions. Also, the people picked, like yourself and Ben, are people who think in that way anyway. But I wonder if there's a missing step. You know, we're talking about digging for the why in terms of students and pupils digging for the why, but there's a sense of teachers digging for the why in the pedagogies that they're using in the classroom. I think that needs to fit into this somewhere. With the workload issues in schools at the moment, we seem to have squashed that out of being a teacher.

**Ben: 30:23**

I agree that a lot of it is a workload problem. You just don't have time and creative energy to craft the spectacle, the high points that actually do it. And that's a difficult thing to solve. I don't have an answer for it. There is another problem though. Just to sound really pessimistic, I think you have to have mathematical confidence and awareness for those questions to occur to you. If you are just teaching the content, this is how you do this technique, and you don't know where that technique goes next, let's say you're teaching GCSE maths, if you've never taught A level, let alone beyond, those questions will not arise, the applications of the things you're teaching will not be obvious, and although I think you can functionally get through the content well, I think you are a less able teacher to demonstrate the why, which is kind of the point of this. It's a difficult thing to solve because we are lacking in mathematics specialists in education in this country. It's the thing maybe I fall back on when we question our jobs sometimes, like, why am I doing what I'm doing? As a maths teacher, the answer was not because more people are now numerate. Actually for me, it was because I get to teach people how to think. That felt a bit better, but now I feel like that's still true. But I'm raising the possibility of a generation of more people less turned off by mathematics. It's necessary to show them these bigger pictures and the digging for the why. We don't have enough specialists in schools to do that. Someone has to make sure that gap is still visible. Like here are some of the whys. Justifying my existence again here. I think I agree with you on that.

**Andy: 31:57**

Some of the work that I'm involved in at MEI that we're looking at projects to get involved in is about raising, it's not just, you know, Alison and I discussed in the first season what happens to students, where do they lose and why do they lose that curiosity around maths and what happens? You know, my three-year-old and my six-year-old never stop asking why. Literally never stop asking why all night long, blah, blah, everything. You know, I've moaned about my children before. I do love them. Don't worry. But something happens, and what we've kind of come to think about, and Alison and I have discussed this, not on the podcast really, but is parents. You know, we talked recently about when the government talked about maths to 18, and you get famous people coming out and saying, "Oh, I hate maths," blah, blah, blah. It's not the famous people. It's adults. It's parents that we need to get more comfortable talking about maths. We need to make conversations about maths more common. You'll be doing this now, then, with your kid. You'll be reading to them. You'll be reading books to them, and you inherently will start talking about maths with your kid and that just will happen. Alison's done it with her teenager. I do it every day with my kids. My wife shouts at me and stuff when I make her explain fractions to me and things and get her to encourage her to do their work herself. Yeah, I am still that person. But how do we get that? How can we encourage the nation to talk about maths, to like maths more, to not be scared of it, to have this kind of, you know, this conference that you went to, you mentioned at the start is about this public perception of maths. Just about, you know, how do we raise that? What can we do? How can we improve?

**Ben: 33:48**

At the risk of going on a rant about it, because clearly that's what I'm here for, to go on a rant on the record. But the digging for the why question, which you are obviously aware of for reasons in the title, is desperately important. If you tell people about maths, I think they turn off a bit, that's the stereotypical reaction. But actually, if you just tell people something interesting or listen to their questions, which I think is maths by another name, it is rational thought and questioning and not taking someone else's word for it. That feels to me like what maths is about, then we can redeem it slightly. It turns out that numbers are the way we answer a lot of those questions. And that's why the maths comes in.

However, the curiosity, as you say, is the thing to harness. And I think that's a pedagogical thing that I've enjoyed having time to play with, like, sort of providing a hook for curiosity helps people ask questions. Why? And then the motivation is there to do what happens to be maths to answer the questions. But then your job as a teacher or presenter or performer is to provide the mathematical moment of curiosity or surprise. And so this is an emotional thing, this is not a content thing like, I need to teach you fractions. Actually, maybe you do. But if you show them something desperately surprising, and suddenly they ask you about fractions, the same outcome might be easier to achieve. Now, I'm not saying this is easy, but if you keep your eye open for things which do provoke the questions that lead you in the right direction you want to talk about, that's a good way of planning some pedagogy. But you just got to look out for those things. The reason I'm getting here is that I've often reflected and talked about and tried using magic tricks for this purpose. I'm not talking about Harry Potter level stuff because I can't do that. But hey, magic tricks are self-aware that they are tricks. There's a clue in the name. These are deceptions. This is misdirection. This is a piece of entertainment. It's a bit of performance done for fun. That is its only purpose, but they are fun because they spike your curiosity. They sort of poke you like that's not possible. And suddenly your brain's like, but so what did happen? And I think it's a really neat example of getting people to ask the questions that you, maybe as a teacher, want them to ask so that you can explain how things go.

I'm a massive fan of using silly magic tricks or mathematical magic tricks to provoke some curiosity and then trying to harness it. Now that is possible in a classroom. It does take, I think some of the specialist awareness, like you need to have the confidence to do that sort of thing. And maybe there's a personality thing like doing cheap magic tricks in a shameless way is not everyone's personality, but it is a really nice thing. And I've definitely used that in maths inspiration to do a stage magic trick that then provides some motivation to talk about what's going on, but it works just as well on a one-to-one basis or in a classroom, I think. Happy to talk more about that, but I realise I've just splurged a bit about magic. It's got that digging for the why flavour behind it, I think.

**Alison: 36:43**

I think what you said there was getting it in the moment and then harnessing it. I don't have the odd thing that you do where you end up with; it's always a multiple of nine, and so,, therefore,, you get a nine at the end of it and all those sorts of things. But for me, it was trying for the children to realise that, in primary school long multiplication isn't a magic trick. And actually, if we think it is a sort of form of magic that we do all these things, go through these steps, and out pops an answer, it's the questioning of why around that. My feeling is it should never get to that stage because it's representing what you've learnt about in another way or using other representations and means of recording. Having sort of tried to live these sorts of maths lessons with children in primary schools, the comments that always surprised me were not necessarily from the children, but were from the other adults in the class. I used to get given that group that wasn't on track for SATs in year six, go and do something with them. The other adults who were there in droves because of the different needs within the groups would sort of come to me at the end of the first half term and say, I've never thought about maths like this before. I've learnt so much, and this was not me blowing my trumpet; it was me feeling sort of saddened that you started to see the depth of the problem around the attitude towards maths. I said to somebody the other day, I knew I was making

progress with this class when I got them to cry. This was not a really negative thing, but we realised they were crying because they actually cared about what was happening at that point. Some of them were happy tears because they'd done well, and some of them were frustrated. I shouldn't really be shouting loudly about getting children to cry, but there was a sense of care is good, getting them to care. That was the key thing. They had engaged with this thing called maths and they had a sense that they wanted to make progress with it. But yeah, that is asking why, and I wonder about how you managed that. I think there's the big moment magic trick on our trip out of school and the lights and the music. It's absolutely fantastic. But it's then almost then like, come on, you're the teachers of these kids. How are you going to recreate this in a day-to-day way and harness that thinking?

**Ben: 39:13**

There is a clarification that you've picked up on really rightly as well, that I want to make sure is heard. A lot of people who don't fully feel comfortable with mathematics or just learn an algorithm to do something, it does look like a magic trick. And that's the same content in a really negative connotation here. It's like, how do you do that? Don't know. It just works. I think if you want to get pedagogical on it, the instrumental versus relational understanding made very famous by Skemp and should be thought about by all teachers at all times. I'm not saying one's better than the other. Both have, like, you can learn an algorithm, and it turns out it works. That's a good thing. You can also understand why it works and having both is better than just one, I think. But I want to emphasise that it can be a bad idea to use magic tricks because you can reinforce the idea that maths is a set of algorithms that just work for no apparent reason. That is emphatically not what I'm trying to do. So it's really important that you do what you mentioned, Alison, and make sure you harness the curiosity that comes from seeing something which surprises you, and you don't understand and turn it into a desire for understanding, which then may take some unpacking and some work. But without it, we're doing a disservice, and that's important. Cautionary note, both bits need to be there. Doing a cheap magic trick and then laughing in their face when they don't understand it is not what I'm going for here.

**Andy: 40:32**

It's making me remember in A level maths in integration, you've got integration by inspection. My friend Joe and I used to share a class at one of my old schools. My Twitter handle is desire to understand. I've always had things about problem-solving in maths. This is the point of maths, problem-solving. This is what you're learning it for. You want to understand, ask questions, all that kind of stuff. I'd bang on about that with my A level class, and then you'd get to this point around February, March time in year 13, and you get into kind of integration by inspection and they've learnt some rules and they've done a bit of chain rule and all this kind of stuff. And then I'd write on the board integration by magic. And they'd be like, this just works by magic. And they'd be like, what do you mean? So you'd write it on the board, and you'd go, Oh, here's the answer. And they'd be like, Oh, it's just magic. It's like, well, where's the working out? It's just magic. And then get so confused because, you know, we were trying to teach them in the right way and encourage questioning and all that kind of stuff. And then a fellow teacher who shared the class, she'd walk in and go, Oh, are you doing, are you doing integration by magic today, Miss Lumley? I'll be like, yeah, we're doing it by magic. And they go, how does it work? And she'd go, it's just magic. And then obviously, we would unpick it, and the kids would look into it and try and figure out, well, hang on, it can't be magic. Why does it work? How is it working? And there's a really...

**Ben: 41:52**

Lovely moment. If you've got a student going, how does it work? In your classroom, you know progress is available, right? Yes, that's a really good moment. But I really think these are nice examples of pedagogy. It's not which order do you teach stuff and what's your classroom questioning. Those things are important and desperately important. But also it's how do you harness the motivational effects that we all have as human beings? Like what emotions can you provoke in order to use them? You've got to use them. But you've also got to provoke them. So I

really liked your example. I think, when I teach integrating factors, which is further down the line, I call it a magic multiply. Like, here's an equation, I can't solve it. I'm just going to multiply by this magic item. Boom. Now it's really easy to solve. And again, it feels like magic, but as long as you're presenting that as like, this is so good that we're going to use it, but you should be asking, well, why on earth does that work? And I think this is a pedagogical thing that all teachers are aware of, but it actually gives you permission to have a bit of fun. If you can provoke that question, it's easier to provide the time afterwards. You've sort of bought the fuel to motivate the exploration.

Maybe to finish the magic metaphor, I find it fascinating that magic tricks as a magician and teaching as a maths teacher feel like polar opposites. Magic is about misdirection, mystery, obfuscation, and making something appear unreasonable, and teaching is about clarity, clear explanation, removing the mystery, and lifting the fog. They are literally opposites, and yet, because they're so opposite, you can use one to provoke the other and vice versa. I get really excited. You can hear, I'm getting excited about it, but it satisfies the performer teacher in me, because you get to create a bit of spectacle, even on a really small scale, provoke the human emotions that we all have, and that in the end are the reason why any human ever studied maths in the first place. Then you have the fuel to go off on the well-worn path of explaining what's going on. But nobody does anything without motivation, as we've already discussed. You're just paying attention to that first bit of providing some motivation. I love the opposites of magic and teaching. They're literally opposites. And yet they work together.

**Andy: 44:04**

I recognise we're getting towards the end of our time here. I always start to think at this point, what's the takeaway for the person listening? If they're a teacher, if they're a lecturer, if they're just here because they know who Ben is, if they're listening to this, what's their takeaway? I think for me, if I'm thinking with my teaching head-on, it's that whole idea of there are so many ways to teach maths. There are so many ways to do a lesson. Sometimes I used to say to the kids, you know, Guys, I'm really sorry. Today's a pretty boring lesson. We've just got to do some practice. Like we've just got to do some practice. We've played around. We've talked. We've looked at these things. We just need to make sure we've got these skills down, and they'd be like, okay, that's fine because they know something else different might be coming. But then you've got lessons where you do a magic trick, or you've got lessons where you might show a video to get people talking, or you've got lessons where I used to love getting kids stuck. I'd put a problem on the board that I knew they couldn't answer. But I also know in a couple of lessons' time, you will be able to answer. But if I've led them to the point in the right way, they're going to ask the questions that are going to take us through the next two lessons as if they've done it. Whereas I've planned it. I know exactly what we're trying to do, but I'm going to let them lead me through this. And then they're feeling this power of, Oh, but Mr. Lumley, how do I do that? Oh, well, I can show you how we could do that. Like, let's talk about that. What could that look like? What have we done before? And all of a sudden, they're asking the questions. And then you've got your traditional three, four-part lesson. There are so many different ways to teach maths lessons. It shouldn't always just be one-way fits all. And you can't always do it by getting them stuck every lesson. You can't always do it by here's, here's a load of practice that we need to do today. You can't always do it by bringing a guitar in or doing a magic trick. That can't happen. But teachers have got to have that arsenal or that willingness in their head. And they're thinking to go, right, what might work here? What could just grab them again? I don't know. Alison, you're nodding along with me.

**Alison: 46:06**

It was that final question you asked. Are teachers actually, you know, having the licence, I suppose, to look at the content of what's coming up and going, what's going to work best for this content for my kids? And that, I think, is the bit that I can't conjure up extra hours in the day, but if you've got your very prescribed set of planning there, and some of the heart, the board has been taken away from you, but looking at how you're going to present that to the children, what's the best way to put this over. And I want to challenge you on your skills. We've just got to practise

these skills because I think those can be some of the most interesting lessons, because if you present the skill in different ways, we've got, okay, we've got a strategy to go through here, but I'm only going to give you some, I'm going to give you some bits, but not others. Have you got enough information to do what we've been working on? And can they? In teaching for mastery, we talk about revealing the structure of the mathematics, and the structure of what's going on underneath it. How does that number relate to that number in this problem? I always go back to my little lad in my last ever class, who always, whenever there was a word problem, would look at me and say, is it add or times Mrs. Hopper? Because he could do adding, and he could do timesing. He never asked if it was subtraction or division because he wasn't so good at those. And I always go back and think, what should have happened for him in the six years we had him in that school that he didn't need to ask, is it add or times Mrs. Hopper? That he knew how those numbers related to each other, that structure. And if we'd spent more time thinking about how we taught and why we were teaching it in that way. I think he'd have asked different questions.

**Andy: 47:41**

That's really nice. Okay. It feels like a time. It feels like we've had a great conversation journey there as usual. We've asked one or two of our questions, but we've been able to just kind of talk about maths and education and teaching. It's great. There's a brilliant magic trick in a Derren Brown book where he explains how it works and everything, and you can learn it. I've done that in class many times, and it only works because of probability.

**Ben: 48:08**

Is it the NCETM one?

**Andy: 48:10**

I can't remember. It's basically two cards. If you shuffle the over-shuffle type thing, the chances of splitting these two cards up are so remote that the trick is going to work. Sometimes it doesn't work. And that's quite nice actually, because you give it to a kid and they'll do the split deal, and you go, Oh no. But generally, the majority of people shuffle poorly, if you like. Therefore, the chance of splitting these cards up is so small that actually the risk of repeating ourselves.

**Ben: 48:38**

That's a nice example, just to go back, of like, right, probability says such and such, blah blah blah, and then it is in your mind, you're like. But does this work and doing it as a trick is a way of, can we actually do this? And then sort of backing yourself on it. So it's a nice example of like, ah, and then you turn it into a tiny spectacle to pursue some probability chat.

**Andy: 48:56**

Exactly. And it's having those opportunities to open those conversations, which is, you know,

**Alison: 49:02**

Can I finish with a quote I found it and it just speaks exactly I think to what you were saying. It was in, I think it was the last ever edition of MEI's M4 magazine a few years ago. It said, if you're studying French then you start with Ouelles le Char and hopefully by A level you're reading Proust. What worries me with maths is that the progression is rather like walking around the bottom of a mountain. You cover the same ground again and again, but you never get any good views.

**Ben: 49:26**

Where's that quote from?

**Alison: 49:27**

It was Hugh Hunt in MEI's magazine a few years ago, and I've used it a lot when talking about, yeah, fantastic. It's very true. I just thought that really linked to what we've been talking about anyway.

**Andy: 49:42**

Fantastic. Okay, Ben, thank you so much. I know we've gone a little over our time, but thank you

so much for coming on and allowing us to have our little gremlins that keep appearing on our podcast recently. Hopefully, when you're listening to this at home, you'll be like, what gremlins? I didn't notice anything different. Then the editing has worked. But believe me, things keep trying to get in our way, which is annoying. So thank you, Ben. Thank you, Alison, as usual. Thank you for listening. Hopefully, you can take something away from this. If you want to get in touch with us, all the links to everything that's been mentioned will be in the notes and our Twitter handles, etc. If you have any questions for Ben, I'm sure he won't mind you getting in touch with him on Twitter and saying hello. Hopefully, we'll talk to you again soon. Thank you so much for listening. Catch you next time. Bye bye.