Transcript

Digging for the Why – Season 2

Episode 3 – Creating Safe and Encouraging Learning Environments with Alex Bellos

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Podcast Link Here

Special Guest: Alex Bellos

Andy: 0:20
Hello and welcome to this episode of season two of Digging for the Why, the podcast for maths teachers, where we explore thoughts behind asking why. I'm Andy, one of your hosts, and I'm joined in the virtual pod studio by my co-host Alison. Hello, Alison. How are you?

Alison: 0:34
I'm extremely well, Andy. Thank you.

Andy: 0:35
Very good. Now, I am, in all honesty, a little starstruck today as we're joined by someone who helped me with the last decade of my teaching of statistics, Alex Bellos. If you are a maths teacher, you'll be familiar with that name, and you may sit there and wonder why. So I did my digging and a bit of background research. The reason Alex is here is because of a couple of books he has written. Alex studied maths at Oxford and then went into journalism, working for *The Guardian* in London and became their South America correspondent, living in Brazil for five years. He then returned to the UK and published *Alex's Adventures in Numberland* in 2010 and the follow-up *Alex Through the Looking Glass* in 2014.

Why did I ask Alex, who has not been a teacher, as you can see from that bio, to come onto this podcast? Well, it goes back to a chapter about baguettes in the first book. I was teaching statistics and reading this book, just enjoying it as a maths teacher, and this intrigue about the lies bakers might tell you about the weight of their bread led to this whole thing about the normal distribution. That came into my teaching and became the introduction for the rest of my teaching career, essentially. The whole book, if you've not read it, poses questions of why about something or wonders about something. Then this adventure happens where Alex delves into the maths behind things. As I used to say to my A level students, the first half of these chapters is accessible to everyone. The second half delves into some deep maths at times and can be difficult to read and comprehend. But the first part is just a joy to read.

Anyway, there I am, a little bit starstruck. It's a good job we're doing this virtually, otherwise, I'd probably just sit there going, "Oh!" But anyway, Alex, welcome to this big intro. Welcome to Digging for the Why. Thank you so much for agreeing to come on. How are you doing today?

Alex: 2:41
I'm doing good. I haven't thought about those baguettes in a long time. It's giving me, you know, a nostalgic feeling. So, to explain what I did, I went to my local branch of Greggs every day for a hundred days and bought the same baguette. I didn't throw them away so slowly; this is a picture in my book of my kitchen with about 100 bags in a big pile. The idea was I'd measure them every day and then you'd see there is a normal distribution. But actually, because I'm more of a pure mathematician than an applied mathematician, it's not perfectly normal because I didn't account

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for temperature, time of day, and other factors. It was a bit skewed, but it got the point across. It was really fun to do. Whenever I invited people to my flat, they were horrified. I was lucky that I didn't have any rodent friends also visiting. Yeah, I really liked it.

Andy: 4:05
I liked to engage my A level students in conversation to get them asking questions and curious about things. It was things like that. I'd put that on the board, and they'd ask, "Why did he do that?" I'd respond, "Why do you think he did that? He's a mathematician at heart. What's he trying to find out? What's he looking for?" They'd guide themselves towards understanding a normal distribution. Then we'd talk about, imagine you're the person that makes these baguettes, you're in charge of Greggs. What are your limits on either side? How far below 150 grams, or whatever it was, are you going to allow it to go? Or how far above are you going to allow it to go? Then we got to confidence intervals and other concepts. It was such a nice narrative to bring into a lesson to help students understand that it's not just us boring maths teachers asking these questions why?

Alex: 4:59
Yes, I mean, it's totally right that I'm not a teacher, and it's good that you pointed that out. I wouldn't ever say that I have advice for teachers. My experience is in telling stories. The stories I write try to engage people straight away. I don't really say it's about maths. I just try to tell a fun story. I think the minute you say, "Hey guys, this is maths," you're going to lose some people. You just want to tell a fun story. I'm happy that you recognised that. I'm trying to do exactly that. You know, some maths, but because it's marketed with maths themes, anyone can start reading any of those chapters. I always made an effort to ensure that even those without a professed interest in maths could read it. Once you start reading, you realise you need to unpeel the layers to understand what's going on. So, I'm kind of doing this exploration in a narrative way, telling a story.

The stories I tell always have three components: the history of the maths, explaining the actual concept, and my own experience. For example, with the baguettes, I could have told the story of Poincaré, who did something similar to avoid being ripped off 150 years ago, but it would have been drier. So, it's my take on these experiences that brings it all together. It's my personal story that serves as the glue. The title *Alex's Adventures in Numberland* is a pun on *Alice's Adventures in Wonderland*, but it also emphasises my presence as the guide. My first book, *Futebol: The Brazilian Way of Life*, came from my five years living in Brazil. I recognised that I was translating these stories from Portuguese to English, and I did the same with the maths book. I feel like a foreign correspondent in the world of maths, explaining it to a non-maths audience.

Andy: 8:28
That's an interesting process. As a mathematician and a teacher, I enjoyed the depth of the second half of your books. When you're thinking about the different chapters, how do you figure out the level you want to get at mathematically versus prose? How do you plan who you're aiming at? Who do you think is reading the book, and how do you address those different levels?

Alex: 8:59
That's a brilliant question. When I wrote the book, I aimed for the non-maths audience, those who said they don't like maths but would find it interesting. There are lots of great maths books, but often they are written by mathematicians. I felt I had to write the book that only I could write, bringing my background as a foreign correspondent. I had two readers in mind: one who liked maths and another who wasn't interested in maths. At all times, I considered if both types of readers would stay interested. It's challenging writing maths because you have to balance the difficulty level. It took many rewrites to get it right.

I realised that to make it interesting for those who grasp maths quickly, you need to fill it with anecdotes. The maths community loved it because these anecdotes were new to them. Maths teachers found it useful for adding interesting elements to their lessons. For example, one chapter

is about zero, which was invented in India relatively recently. Instead of just stating that zero was invented in India, I went to India, described a priest who embodies the concept of zero and made the story engaging. These literary tricks are essential to keep readers interested in maths.

Writing about numbers is challenging because the brain reads digits differently from words. You need to minimise digits to keep the reader engaged. The book *Maths Without Numbers* by an American author does this brilliantly. I love puzzles, and writing about maths feels like solving a puzzle. You have to craft it carefully to balance the difficulty and keep it engaging. That's what goes on in my brain when I write these books.

Alison: 14:42
I think I've found this really easy. I've just been jotting down some things because I couldn't hold it all in my head, but there are a few things you said that resonate with a lot of the work we do with teachers. I know you're not from a teaching background and wouldn't hold yourself up as a guide to teachers, but some things struck me. I was reading the other day about engagement in itself, that students being engaged in lessons isn't enough. I'm still trying to process that because I think there's an element where they need to be engaged. You mentioned hooking readers in with something interesting and starting slowly with different readers in mind. One of the things we talk about a lot with the teaching for mastery stuff at the moment is going slower to go faster. If you can secure that basic underlying concept, you can build on it and develop it. You also used two words, "understand" and "get it," which I always listen for when I hear teachers talking about children and their learning. Sometimes we get the "know it and do it," but the "understand it and get it" is a deeper level. It's the why, the understanding of the why. I found that interesting, taking it into the world where I work with professional development for teachers. There were lots of things you said that echo the way I hope we at MEI and NCTM try to engage with teachers and get them to think about maths.

Alex: 16:20
I think sometimes it's nice reading something you already know because it reinforces that deep understanding you have. It shouldn't always be about the new; sometimes, going over in a methodical way is really good because people like to feel intelligent. If they read something they already know, they get the pleasure of "I know that" and it reinforces it. No one minds having that stuff reinforced. You put a little humour, a little anecdote, a little history, and it makes it enjoyable. Another thing about maths, which I wrote about regarding puzzles, is that maths is very satisfying when you get it. Puzzles epitomise that. You don't get it, and then suddenly you do, and you get that "aha." Even in books, in a slower sense, you're always getting that feeling of "Oh, I get how it works. Oh, it fits in. Oh, that makes sense." The foundations of all mathematical knowledge are really pleasurable. I'm not going to ask a psychologist why, but it really is pleasurable to have that reinforced. What is not pleasurable is reading something you don't understand. You never want to put someone off because that puts you in crisis mode. You can know it, and it's nice to have it repeated. For example, I like to read the New Yorker, and it often has pieces about England or Britain. I know everything in that piece, but it's refreshing reading someone else's take. Maybe that's what I do with maths. Lots of people know everything I'm writing about, but because it's a slightly different take, it encapsulates it in a satisfying way.

Andy: 18:45
That's interesting. One reason we set this podcast up is the idea of asking why. We want to ask it of our students while they're learning their maths. Why did you get that answer? How did it work? Can you explain it more to try and get them to understand the meaning behind it rather than just regurgitate? You can hit a brick wall in maths around year nine or ten when it gets more interesting, and you go, "Oh, I've only ever just learnt and repeated this. What am I going to do?" We're trying to encourage asking why, and you can almost reverse it. When you're a teacher, you want a student to ask, "But why does that work?" It's challenging the teacher to say it in a slightly

different way, or to put themselves in the student's shoes. You've alluded to that in your writing, putting yourself into the shoes of the non-mathematician and the mathematician to get something engaging. When you do presentations or talk to students about maths, how do you plan to enthuse them about maths and get them to walk away thinking, "That was amazing. I wonder about this. I wonder that"? How can you design what you do to give them that feeling?

Alex: 20:23
You're asking me to give away my trade secrets! I use several different ways, depending on the audience and what I'm there to do. What I never do, which I realised early on doesn't work, is to try and actually explain and teach maths because that's what teachers do. I'm here to do something different. At one end, I try to do no maths at all but just talk about numbers in a fun way, in a way that maybe they hadn't thought about before. For example, really basic stuff like what it is to count. Can humans count? Can chimpanzees count? I have videos of chimpanzees counting and parrots learning to count. What does all that mean? Young children, and we all are, find talking about animals interesting, and it grabs their attention. I show amazing videos of chimpanzees doing things with numbers that you can't quite believe. It grabs them, and it's a "wow." Then you use that to let them ask questions and take it whichever way they want to go. I have videos from when I went to Japan researching Numberland and got interested in the abacus. Kids in Japan around key stages two and three learn through the abacus in afterschool clubs. I show videos of kids doing amazing things with abacuses. When you get good at the abacus, you can do something called Anzan, which is imagining the beads in your head. They can do amazing mental maths tricks. That always gets a "wow", and it's interesting. I might mention numbers, where they come from, and how maths is a universal language, but the approach to maths varies around the world. I hope that I've shown here a guy who is really into maths, isn't particularly nerdy, makes funny jokes, and talks about interesting things. It counters the idea that maths is not useful or interesting without trying to. Maybe next time they do maths homework, they'll think, "I kind of get why we're doing this."

Another talk that I find surprisingly successful is about an online survey I did about 10 years ago to find the world's favourite number. I did it because I don't have a favourite number and wanted to prove it was interesting. Forty-four thousand people joined it, the largest survey of its kind. The thing with favourite numbers is that everyone has an opinion, irrespective of whether you're good at maths. People who are good at maths might say their favourite number is pi for some complicated reason, but people who hate maths might say seven because it's Cristiano Ronaldo's number. Everyone has a reason and wants to take part. You can start by talking about favourite numbers, which I initially thought trivialised maths. But now I realise it's not. It's open access. I've spoken to PhDs at Google and primary school kids about favourite numbers, and everyone is interested because it's about their personal interaction. Once you start, you can go as deep as you want. You can engage at a primary level or take it all the way to degree level. You've started by getting everyone involved.

For big audiences, like an entire key stage group, I've learned by accident that doing puzzles the entire group solves together works well. It's like being a stand-up comedian with a set of gags. Puzzles are like that. You have a short puzzle and a long puzzle, and the puzzle can go as deep as you want. With a puzzle, you have amazing interaction. You can ask, "Who thinks the answer is A?" and see people looking around. Then, "Who thinks B?" and more people vote. Everyone has skin in the game. Puzzles create that "aha" moment, and then you quickly move to the next one. If someone was daydreaming, they don't need to have been concentrating for 60 minutes. You keep going, bang, bang, bang. Geometrical or visual puzzles tend to work best because they're easier to follow on a screen.

Andy: 28:34
Take that, the more abstract maths rather than what kids think is just numbers and sums and stuff like that. No

Alex: 28:40
Equations, like totally no equation. And also what works. There are so many fun, different things you can do if you've got a smaller group. You've got these ones where you can bring two kids onto the stage, and they can hold; you can interlock them because they're holding a rope, but the rope is connected. How they kind of untangle themselves, and that can sometimes, if you do it wrong, it's complete chaos, but you do it right, it's like really, it's really good. And you get kind of basics, the basics of topology because you think it's two interlocked circles, but it's not two interlocked circles because it's, it's a loop around the wrist, which is another circle. And it's basically, you sort of go into the loop around the wrist, and then it just makes you think, oh, I get it. That's interesting. And you might think, well, what does that have to do with maths? It's nothing to do with algebra or adding. And so I quite like just sort of the key, it's got to be either fun. Well, there's the element of surprise and fun and learning. And it's the, it's the aha, the aha. Also, the nice thing about puzzles is that they all have an answer, and you want to set a puzzle that is, they might not get in the time they're set as an audience, but they would ultimately, if it was just themselves, probably be able to get even if it took a bit longer because you know life is full of so many problems that don't have answers that you can't do, it's really nice thinking, okay, there are these little baby problems that you can solve, and you can do, and that's really nice. And actually, if you learn how to solve these little baby problems, which is kind of what maths is, you know, someone I can't remember, Jordan Ellenberg or Eugenia Cheng was one of these maths writers. So the whole thing about maths is that maths is there to make things easy. You think that math is there to make things hard, but actually, maths is there to make things easy. So you've just got to take one step back. Yeah, yeah, yeah. Reframe that initial sort of judgment.

Andy: 30:46
I used to have, I've said this before on the podcast, but I used to have in my classroom, I had two things. I haven't said the other one, which also I think I basically stole from your book. But the first one used always to say, you know, maths is problem-solving. Problem-solving is thinking. Have you thought? Because you'd get kids in that their first thing in class is just go, don't get it. And be like, okay, well, don't you get, you know, what are you talking to me about that explains to me where you're up to? This is about problem-solving. Have you tried to solve the problem? Have you broken it down? Have you done this? We've done this. And that's kind of what you're saying there about that's the beauty of maths, right? It's, it's Yes, it is a universal language if you like, but it's done in so many different ways. But at the core of all of it is maths is about breaking things down into a smaller chunk that you can figure out and then expand and learn and build those foundations and build those big blocks up. The other thing I used to have on my wall, which I think came from your zero chapter, basically, was that zero is nothing and everything. Yes. And the kids used to read it and be like, what does that mean? I'd be like, well, what do you think it means? You know, how many elephants are in this room? And they'd be like, what? Like, well, there's zero elephants in this room. And they'd write, you would do some measurement work, and I'd set it up. So the answer was zero for a length of something. And they'd write zero centimetres. I was like, is it zero centimetres? And they're like, what do you mean, Mr Lumley? Well, if there's no, if there's nothing there, there's no measurement. Does it need centimetres? And just, just to try and do something to get them thinking that's different. We used to do a carousel in one of my schools where the whole aim was to take year seven and do something that had nothing to do with the curriculum at all. I used to do combinatorics stuff and take them, imagine them going to the cinema and they're going to sit in a line and how many different ways can you sit? And, you know, you've got 20 kids in the classroom. That was a private school. So 20 kids in the class, and you're getting into the billions of different combinations that they can sit in, and the kids sit there going like, what, and it's that little level of engagement. It's exactly what you're saying about your talks. Just. Something to interest them, you know, maths can become this monotonous thing of, here's some

questions, do some questions, here's some questions, do some questions. And obviously what we're about here is saying, we don't do that. We don't need to do that. You know, we can do a lot more than that. You know, Alison is our primary expert and it's, it's been really interesting hearing the things that you've said, Alex, knowing Alison as I do now and having done the first season of the podcast together. And so many similarities between what you're saying, work, writing for everybody, producing, you know, presentations for different levels of kids. I know Alison's been doing exactly, does exactly the same things and has the same mentalities as her teachers. And then when she's working with five-year-olds, six-year-olds. What can you apply from what Alex has said, Alison, for that primary school teacher?

Alison: 33:38
I mean, there's loads in there. I think part of it is the slowing down of the starting of things and finding the hooks. It's finding that way into something which gives a reason for it, which seeds that question of why, because I think we can, you know, we like to ask why that, you know, and there are teachers who will question why. But what we really want to do is foster that. That is why that comes out of young children all the time. You know, they constantly ask why, trying to make sense of what's going on around them. And at some point, we lose that. And I think it's that engagement that says, hang on, I want to know why this works. I want to ask why this works. I want to see what's going on here. Well, hang on. If we move that to there, why does that make a difference? And the questions you were talking about with the zeros and what have you, and, you know, do we need centimetres if there's no measurement there? Or do you know what to? What do we need to talk about? And I think we get very formulaic, very quickly with children, too formulaic, too quickly, and we squeeze out the questioning and the sense-making and what you were saying about those aha moments I've bored Andy with it lots of times before, but I had a moment of realisation with a group of very, very high attaining mathematicians. They were top-end junior schools, so year sixes, and one of them, we were working on some problems, and one of them went. Oh, and then explained what was going on, and I said, oh, you've had that warm fuzzy feeling I heard about on the radio. Someone had put the warm fuzzy feeling in the Museum of Curiosity on Radio 4 and this group of children, and it was a mixture of boys and girls, looked at me as if I'd lost the plot yet again. It was a look that was relatively common when we were working together, and I explained the story about it. So, there were about 12 of these very high-attaining mathematicians, and half of them, when I talked about the warm fuzzy feeling, went, oh yeah, I know what you mean. And what scared me rigid and shocked me was that half of them didn't. And I think that you know, a lot of what we're talking about here is that, that personal engagement with it and those moments that lead to, and we can, you know, we can go into all the cognitive science stuff around it as well. But I think sometimes that's the bit that's missing and we're not engaging them with it. We're not engaging the teachers perhaps with it in a way that says if you, if you find this way in if you really expand that early bit of the new introduction of a new concept and really secure it and generate those aha moments and those warm fuzzy feeling moments and support our pupils to recognise that this whole digging for the why would become an absolute core and fundamental to the way we teach maths to children. It was a bit of a ramble, sorry.

Andy: 36:48
It's just interesting, isn't it, to talk, you know, we spend our daily lives talking to teachers and working with teachers, and we've been teachers and knowing kind of what it's all about in the classroom. And it's just really interesting to hear the similarities really in what you do, Alex, which is completely different to teaching in terms of what you're planning and stuff. Now, I'm going to ask you a question here. We're kind of getting towards the end of our time here, but I'm going to ask you a question, which we normally ask at the very start, which is, in the last couple of weeks, has anything happened that's made you ask why?

Alex: 37:23
I mean, that's such a big question. It depends on what level to take it. The first thing I thought of, which maybe is not entirely relevant, but that was what I thought of, you know, is that I'm getting

quite interested in computer science. And I have noticed that there are almost zero books aimed at Key Stages 2 - 3. Well, Alex in Numberland has probably stated 3, 4 and grown-ups, but the ideas are definitely, you can explain Key Stage 2. There are no good books on computer science. There just aren't. Computer science is the fastest growing A level, computers dominate the world. So I've been going into the British Library and trying to read everything that anyone has ever written on the basic concepts of computer science and trying to find out why this is such a massive area, and there's not that much stuff about it. What you have, you have textbooks, you have academic books, but there's no kind of thing that makes it exciting and engaging. And I'm interested in two reasons. One I'm interested in because, you know, I make my living from writing books and if there's a big gap there, then I want to go and fill it. But I'm also just more fundamentally, well, what is it about the way we teach maths, the way that we teach computer science, the way that we exercise, use computers? You know, I think that math famously has an image problem. I think a lot, lot less now than when I was, when I was a kid. But still does a little bit. Computer science has a different, but also does have an image problem. And like, what is that? And in the future, I think that computer science is going to become more of a maths subject and less of a kind of engineering subject. And so that's, I mean, maybe that's just too high level for this podcast, but these are the big things that, you know, I'm thinking about at the moment, and when I go to bed at night, these are the questions, and I don't really have any answers, but that's, that's where I'm going.

Andy: 39:43
But that's the challenge, right? That's the whole point of being a person that wonders why you're not just going to stop. You're going to go on now, hang on, what, what's next? You know, why is, why is there a gap? Where is this? Why aren't people writing it in this way? Why aren't there these things for these kids? It's interesting, isn't it? Because, you know, my kids play computer games on their little tablets. And essentially everything behind that computer game is decision maths and algorithmic and, you know, how it works, and it's vectors, and it's everything. I could see, I can easily see some kind of new A level, which is maths and computer science.

Alex: 40:21
Before you mentioned teaching your kids combinatorics and how it blows their minds, with only five people, there are about a hundred combinations, but with 20 or 30, it’s billions. That’s a computer science issue, all about trade-offs to avoid too much complexity. It’s no longer about theoretical maths but practical application. Viewing problems differently from how I learned maths is interesting.

Asking why is a journalist’s job, and I’ve got a degree in maths and philosophy, then trained as a journalist. The overriding life skill of journalism is not being afraid to ask questions. If you don’t know something, just ask. Yesterday, I was in the library reading a ten-year-old book on computer science. The author predicted something, so I wrote to him asking if it happened. I learned this opportunism from journalism. He replied, suggesting a Zoom call on Wednesday. He’s a professor at an American university.

Good journalists can be annoying because they question everything. It never hurts to ask a question, and everyone should learn this journalistic skill. Don’t be afraid to ask questions.

Andy: 43:29
We’ve discussed before how my three-year-old never stops asking why. When does that curiosity disappear? We talked about this in season one, questioning why children stop asking why and just follow instructions. It’s crucial to maintain that curiosity. A good takeaway from this podcast is to ask why, regardless of your age or background.

Alex: 44:13
It’s not embarrassing to admit you don’t know something. Intellectual confidence allows you to

acknowledge gaps in your knowledge. Asking questions is vital, even if the answer is obvious. Don’t be afraid to ask.

Alison: 44:43
As teachers, we need to create a classroom culture where asking questions is encouraged. Whether the question is profound or basic, it’s crucial to maintain that culture of inquiry.

Andy: 45:17
Alex, thank you for joining us today. It’s been fantastic. I’m already looking forward to your next book, "Alex's Adventures in Computerland." I’ll link to your socials and website for schools to book you for talks. Thanks for coming on "Digging for the Why." Alison, thanks for your company over the last 47 minutes. Thank you, listeners, for joining us. We enjoy talking to people with a maths interest and learning why they ask why. Alex, thanks again.

Alex: 46:01
It’s been great fun. Thank you.

Andy: 46:04
Enjoy the rest of your week. We look forward to having you listen to us again in the future. Take care. Goodbye.