Transcript

Digging for the Why – Season 2

Episode 5 – Digging for the Yes, but Why with Ed Southall

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Special Guest: Ed Southall

Andy: 0:16 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 am Andy, one of your hosts. And I'm joined in the fellow hosting seat by Alison. How are you today, Alison?

Alison: 0:29 I'm very well, thank you very much, Andy.

Andy: 0:31 Very, very good. Enjoying a bit of sunshine down there.

Alison: 0:34 No, cloudy today.

Andy: 0:36 We've got sunshine up north. So we went one for the north. It doesn't often happen. So I'm going to claim it whenever I can claim it. Now, when we were thinking about season two and who we would want to talk to about Digging for the Why, it was pretty easy to come up with today's guest. He is the author of Yes, But Why? Teaching for Understanding in Mathematics, which basically would have been our alternative title for this podcast, but that had already been taken. So we reached out to him, and thankfully, or maybe foolishly, he said yes. He is currently, now there's a list here coming, this is ripped straight out, don't, don't give yourself away, shh, this is ripped straight out of his LinkedIn profile, so you know, this is pretty good. He is currently the Mathematics Curriculum Lead for Oak National Academy, an author of many maths books, a conference speaker specialising in conceptual teaching of maths, and making sense, no, and making maths make sense to children of all ages. If you go on his Twitter, he often talks about talking to a bot as well, which is quite entertaining at the moment. He is editor in chief of the Mathematical Association, a former school teacher, and member of senior leadership, and also worked in the Middle East for four years. He is, of course, Ed Southall. Welcome to Digging for the Why, Ed. How are you?

Ed: 1:48 I'm very well, thank you. I'm a little bit flustered after that intro, even though I wrote half of it. I particularly like that you threw in that my best friend's a bot at the moment, which is brilliant and pretty accurate.

Andy: 1:59 I do enjoy your Twitter when you're talking about the stuff that you're doing at the moment. That was quite good. Okay. So we're trying to start the season off with a standard question to see what people are thinking about at the moment and what's going on in their lives. So, in the last couple of weeks, what has happened to make you ask why?

Ed: 2:18 Well, I was thinking about this, like, I was thinking, oh, they'll want a clever ‘mathsy’ thing that makes them go, oh, I've not thought about the Y for that, but I don't have one of those. But I do have an eight-year-old and, and he comes to me quite regularly with like amazing, bizarre questions that are actually really good questions, but just, you wouldn't think them as adults

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because we've lived a whole different set of experiences, but he came to me last week basically and he said, and I love this, why is it that the sky is blue when you look up? But if you were at the top of the sky looking down, you couldn't see the blue. I thought that was pretty good. I'm not sure how it's got to the top of the sky, but...

Andy: 3:11 What's your answer?

Ed: 3:11 Because it just is shut up. (laughing)

Andy: 3:13 No, don't give the teacher the answer when you don't know the answer.

Ed: 3:14 Well, what was good actually was, was his brother, who's 15, chipped in with the classic misconception of, oh, it's because it's reflecting the colour of the sea, which doesn't really...

Andy: 3:27 In landlocked Yorkshire.

Ed: 3:27 Doesn't work and also doesn't really address the whole from the top-down work. I don't know. But I just, what I liked about it was it just demonstrated that weird curiosity that you tend to get mostly with like primary school kids, I suppose, because they're figuring out the world.

Andy: 3:48 Yeah. I love that kind of thing. That's something we've spoken about before, Alison, isn't it? Because I've got a five-year-old, no, she's six on my word. A six-year-old and a three-year-old, and they're constantly just questioning everything. And then Alison's got, what's yours?

Alison: 4:02 17?

Andy: 4:03 Yeah, so like that kind of, that, what happens between, you know, five years old and 17. And and where does that curiosity go? And, you know, one of our, one of our episodes on the first season was about curiosity in that classroom. And, like, what happens to it? Do we knock it out of the kids? You know, so I, I mean, that kind of leads into a question then, which, you know, believe it or not listeners, we do have a set of questions, which we send to our guests ahead of time. However, I'm straight away going to go off-topic and just ask you a question which has nothing to do with what we sent you. I'm interested in, in the book, obviously. So Yes, But Why? It's the reason that we first wanted to get you on here. Because obviously you must share something along the same lines as what we think about in terms of education, in terms of teaching. What led you to want to write that book? What, what was that about? What was that? What was driving you to do that?

Ed: 4:55 This could be long. I'll try and keep it brief. I, I have been through a journey with like my relationship with maths and I think it's quite a common journey up to a point. And when I came through at the end, I actually thought this, like where I've come to with this journey, would benefit a lot of other people, I assumed. And so that journey was like being at primary school and being good at, I remember being good at maths. I remember getting the answers right. I don't really remember how it was taught when I was that young, but I did well in it, and I went to a secondary school, and I was doing great at maths then as well. And gosh, I got to sort my GCSEs and, and didn't really work very hard for them, but got good grades. And then I got to A level. I was like, Oh, this is quite a challenging subject now. I really struggled at A level but managed to get good enough grades to get through to university, where I still studied maths almost accidentally, really. I went to Keele University, and you've got to do a joint honours there. And I wanted to do programming. But they, I had, you literally have to take a second subject or you did back then. So I took maths because I was doing all right at it. And I really started to fall out with maths as it were, because it was just really hard. And I don't think I really understood why I wasn't enjoying that difficulty at the time. And it's only as an adult really, that I can see that a big part of it was that

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pretty much the entire time, none of it made any sense to me at all, ever. It was just, I was good at following the rules and the number that popped out at the end was the same one that the teacher was expecting. And I think I was just fortunate because that, that in retrospect, that just feels lucky, really. I don't think I had a good conceptual grasp of most of what was going on.

At university, I think I can hand on heart, I should be ashamed, but I'm not. Like, I don't think I understood anything that I studied at university in maths. I just followed the rules. And that gets you so far, but you really struggle with creative questions and questions that require you to apply stuff to unfamiliar situations and so on. And I always did. Anyway, so I come through all of that. I got my degree, and I wasn't sure what I wanted to do. I wanted to be a programmer, but it was at the point of the sort of millennium bug thing. And so there were loads of jobs going into IT when I was studying and nothing happened. And you came out, and the graduate market for computing just kind of dropped off.

So my mum was a teacher, and she was like, why don't you just, while you're sitting around, you know, taking up space in my home, come with me to my school and do two weeks and see what you think, because at the time there was a good graduate scheme for teaching, they paid off your student loans for you. I was like, that sounds pretty good. And I was just really into it. I connect, like my mum worked at a really tough school and I connected with the kids there and she saw that and she was saying, you know, you've got this, you do great at teaching because you can, you can relate to these. You know, these kids who a lot of people can't and they responded to you really well. And I enjoyed it. So, so I did teacher training. I trained to be a computing teacher, but at an interview at my first job, as, as is always the case, I've now found they went, Oh, you've got a degree in maths. Guess what? You're going to be a maths teacher. So I had no formal training of being a maths teacher, but I ended up teaching maths 50 percent of my timetable for the first three or four years. And it just kept, you know, increasing because the demand for that subject is so much bigger or was then and the career opportunities were so much so much more prominent for maths than they were for computing. So anyway, I'm sorry. This is such a long story. I ended up becoming a head of maths, right? And at that point, I must have been, I don't know, like 25, 26 or something like that. Just pretty young for a head of maths and I kind of it, it, it I had this realisation that up to that point, my teaching of maths had been fairly crappy and had been very similar to how I'd been taught maths, where I was just focusing on, you know, you need to know this rule to solve this problem. You need to know this rule to solve this problem. And so, and I thought, I don't want to be that. And now that I've got this kind of responsibility within this subject, I need to be better at teaching maths. So I just went away and, and I just started researching all the things that bugged me about the stuff that I'd worked on my whole life in, in maths education. Like, why, why is it that this thing works? What, you know, there must be reasons. And I'd never really thought about the reasons until the point where I thought I needed the kids to know some of these reasons so that they don't have this journey that I had of being all right but not enjoying it. And it just became incredibly addictive.

As soon as you start getting those realisations of oh my God, this makes sense. And oh my God, that makes. And oh, so I wonder if there's an answer to this thing. And, and you find that pretty much everything has a really sensible reason behind it or purpose behind it or structure behind it, even down to like the etymology of words in maths, like words are so foreign, they, you know, we don't use them outside of maths ever really in, in a lot of, in but when you start figuring out why that word is structured as it is and how it relates to other words and you go, Oh, okay, it makes sense to use this stupid term. It's not stupid, but it was for 20 years. And I just kept going down more and more rabbit holes and feeling euphoric at every discovery that I made. And I thought I need, I need to spread the word, so I just, it became the book and I feel like, I mean, I'm sure other people should tell me this rather than me assuming it, but I think one of the reasons people find me reasonably interesting is because I'm, I am the same person as them on that journey of not being seen as a gifted mathematician. I struggled with it, I didn't really understand it, but I could

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get through it, you know. And I've come through the other side, so I can, I feel like I'm in a decent position to tell people you can too. It's not, it's not magic and it's not about having some crazy gift or, or like sense around numbers that other people don't have. It's just about being informed and being able to access that information and wanting to know it. There you go.

Alison: 11:59
Yeah, no, it's brilliant. So when you said you went down rabbit holes, I'm intrigued as to where you started looking for the "why," if you see what I mean, and where you ended up finding the beginning of that "why," because obviously I'm listening to this with a primary hat on and had perhaps a similar journey, but not at the same bits of maths. My maths ran out at A-level. I got through A-level by learning how to do stuff, and I can still remember the feeling of getting to the end of a problem and proving that the coefficient of restitution lambda equal to a third and the Hallelujah chorus played in my head. I was very happy. If asked me to do something about the coefficient of restitution now, other than telling you about snooker balls or billiard balls, I would never be able to prove that lambda equal to a third. So my "why" ran out at that point, and it was only when I did my PGCE in primary that little bits of the "why" started appearing to me as I pulled apart bits of maths. Having had the luxury of being able to live a life of thinking about maths quite a lot over the last 20 years, in and out of school as well, I'm intrigued as to where you started looking for the "why" in terms of the maths and where you ended up.

Ed: 13:13
I think probably trigonometry was my starting point. Part of my background is teacher training, and I've seen many trainees get nervy around, this isn't the right terminology, but the top end of the curriculum, you know, the stuff people used to label as the A-star topics, which is ludicrous in some ways. But those elements that start bleeding into A-level, without any conceptual understanding of what's going on, become farcically abstract. You just feel so inept doing anything with it and so lost, with no compass bearing around whether the hideous decimal that comes out on your calculator at the end has anything to do with the question that was asked. You're just hoping and praying it is. You see it in classrooms all the time: the teacher explains stuff, everyone's nodding, and even the most high-achieving students are putting their hands up after every answer they write down because they have no bearing on whether it's right. I was in the role of the teacher and thought, I cannot begin to teach these topics without having a really good foundation of what is actually going on. It's not just pressing numbers on calculators. To my shame, I taught this stuff before and taught it in that way, just like plough through these instructions. Maybe that's because I wasn't trained in it to some extent. I don't know why I didn't take that more seriously at the time. Probably because I saw myself as a computing teacher, and this was an aside that was put upon me. But it was definitely trigonometry when I started thinking, I need to deep dive, I hate that that's become part of our lexicon, before I go in teaching these pupils with it. I had a blog at the time where I used to just post maths problems. I started to write instead of just posting problems on it. I was writing my findings on this stuff, not from a perspective of, "Oh, look, I found this stuff out," because I was kind of embarrassed about that. It was more, "If you don't know this stuff, isn't this interesting?" And those became...

Andy: 15:53
Okay, I'm going to expand on that slightly. Put yourself in the position of a teacher now listening to this podcast and thinking, "This is what I think as well." In my teaching career, I worked in seven different schools, and every single school had people that think like this, wanting to dig into the "why" and the understanding of it. But there are also people who want to know that they can get results and, for want of a better phrase, don't mind if the students don't understand because they're going to get it right. That's okay because we're time-pressured, we've got to get through this curriculum, we've got to do this exam in GCSE. So put yourself in the position now of the teacher who's there, maybe a couple of years in, thinking, "I don't feel like I'm teaching this topic properly. I feel like I'm algorithmically preparing these students to answer a question, and when

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that question is different, they're going to get stuck because they've not got any conceptual understanding." How did you go about working with your heads of department to allow you to take that time to introduce topics in a different way, knowing that if you've got three weeks on a topic, you'll spend the first week playing around with stuff, diving into it, because you know that then the following two weeks, you'll get to the point you need to get to? How did you have that discussion with the head of department?

Ed: 17:22
Yeah, it's tricky. It almost comes from a few steps before that. Focusing on what the practice is turns into more in-depth conversations about how the modelling looks and how we're testing different elements of how much children understand the topic. I think it's easier to get people enthused about practice first and start thinking about what a good question looks like on this topic and how much I actually know that they know when they can answer this question correctly. What level of understanding do I need them to have to be able to tackle this style of question where the purpose is hidden or the maths is hidden? From there, you start thinking, why is this a smart question? How is this question better than that question?

To me, you start working backwards and going, well, to be able to tackle these more in-depth questions, they need to have this understanding. How can I get them to get that understanding? How am I introducing this topic? What does my modelling look like? What does my questioning look like? How can I improve that? An easy way to do it is a comparison of the before and after. Everyone always falls back on something like Pythagoras or the area of a triangle. One of the reasons for that is that both of those lend themselves really strongly towards being able to teach procedurally quickly, but not very well, and teaching it slowly and really going to town on what's actually happening with structures and the maths behind where those formulae come from. If you can get people on board with this kind of excitement of revisiting stuff and improving it, it kind of naturally generates from there. Certainly, in my experience, I found that, I mentioned that I did a blog about writing puzzles.

The reason I used to do that was because I was working in a maths department as a kind of lead practitioner, and no one was talking about maths at all. The staff room would talk about their days, then go off and teach in silos and come back again. The departmental meetings were all about the bulletins from senior leadership. There was nowhere in the cycle of a week where people were talking about what they taught or how they taught it. There was no sense of enjoyment about the subject. So I just started posting these maths puzzles on the board in the staff room, just to see what would happen. Over the course of a month or two, everyone started talking about them, sharing their different ways of solving stuff. It just nudged people to reflect on why they love maths and their subject. It made them realise, and this wasn't my intent particularly, but it made them realise they hadn't done any challenging maths for years because the only maths the teachers were doing was the stuff that was pre-prepared or had been on the curriculum for 20 years. Putting them in a place where they had to solve something unfamiliar fired up their love of the subject.

If you can get people fired up about what they're teaching, they're going to naturally want to talk about what's the best way to teach this? What's the best way to draw this? A student asked a great question yesterday. How did that question come about? What did I facilitate to get to that point? How would you respond to it? That, to me, is one of the most exciting things about teaching. You look at some other cultures and their perception of teaching and how you can never be perfect at it. You can never... It's just this never-ending journey. That's what they find exciting. They don't find that daunting; they find it exciting. That's the thrill of it, that it's... there's this intellectual side to it where you go, how do I constantly do better? I don't think we have that enough here. But if you can latch onto it or nurture that, then you're going to fall into those rich

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discussions about how do I get people to understand this really clearly to A level where they're not just regurgitating, they're thinking hard about stuff.

Alison: 22:20
How did the pupils react? Because I think that's something that's quite interesting. You've found a way to get through to the teachers, getting them excited about maths again. But then changing that way of presenting maths in the classroom is a real difference in the way that the pupils engage. What happened?

Ed: 22:41

I'm going to be brutally honest because I want people to understand that this is normal, or it is from my perspective. My biggest battle in the classroom was getting top set Year 11 to want to know why anything. They could not care less. It's understandable when you take a step back, right? They are in their last year, most of them of maths education. They have had 11 years of being taught in a certain way or being familiar with certain styles of teaching, and they have been extremely successful in that arena. So, to change it at the end is uncomfortable, at least threatening. It's like, I'm really good at this, and I'm holding onto that, and now you're putting me in a place where I have to do things differently, where perhaps I'm not going to feel as successful or even just at a base level. Like, I'm near my exams. I've got this. Don't mess with the system. To be honest, I say this in some of the talks I do. I think it's really complicated how you put why into lessons, which I think we'll probably get onto. But I think it's not going to be appropriate all the time. I think with Year 11, depending on their prior experience, your priority really is to get them through their exams. That's why they're there, right? As a principal, I struggle with that because that's not why I'm there, or it's not why I want to be there. But really, that is what you're employed to do, right? Get them through school, you could argue. Particularly at that point, you don't have time to go, right? I'm going to explain prime factors in way more depth for you so that you're really satisfied with understanding it because that comes at a cost of, oh, by the way, you're not going to know three topics in your exams in a few months. It's definitely complicated, but I think in Years 7 and 8, you can nurture it really quickly. Genuinely, I think the message that I give is that your default at Key Stage 3 really should be, this needs to make sense rather than you need to get the answer right.

Alison: 24:58

Yeah.

Ed: 24:58

That kind of shifts as you move towards exam periods. But if you assume that, that why has been integrated from Year 7, then you shouldn't have to be 100% focused on the answer must always be right by the end. Because that comes with it, but it does take time.

Alison: 25:18

Yeah, no, I think that Andy mentioned his, you know, we seem to have our offspring are all at sort of span preschool to what, well, I think, I think with both of them up in, up at the, the top end and I must admit, it's possibly because he grew up with a maths teacher and an engineer that my 17-year-old, we got over the initial early in Year 7. Just tell me the, just tell me what to do. It was fractions, and it depended on whether you knew the value of a part or the value of a whole. Did you divide by the denominator and multiply by the numerator or divide by the numerator and multiply by the denominator? Just tell me how to do it. And I didn't because I'm cruel and mean and horrible. But the upshot of that is that now we're in the first year of A level and further maths,

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and his biggest bugbear is when he comes home and he doesn't understand why this works, and he gets really, really frustrated when the understanding of why it works doesn't matter. So you said the tricky bit is how you get the why into the lesson, into the lessons. So go on, tell us.

Ed: 26:28

I think it's really nuanced and complicated. People want an easy answer when there isn't an easy answer at all. For example, forgive me for going back to the same blooming examples each time; area of a triangle, right? It's one that everyone can imagine in their heads. I think a poor way to teach that would be, here's the formula, practice, practice, practice, move on. But I don't think there's a right answer way necessarily with the next two examples: model and explain and get to the core concept of this is why this is the formula and then practice and move on or introduce the algorithm, practice, practice, practice, and then introduce like, this is why this formula is right. I was really, really consciously careful when I wrote the book not to promote a sequence of how to introduce stuff. I saw it as these are the explainers that you are probably going to want to use sometimes but probably not going to want to use over time. Some of these you probably will never use, but I think it's important that you know them.

I don't really have much evidence for this. It's just my gut feeling is that there's a default position of I've got to explain the why first. I think that's really dangerous because you take that trigonometry example, or the example I usually cite is the volume or surface area of a sphere. You've got really neat, beautiful, tiny little formulae for those things. To understand where that formula came from is way, way more complicated than the maths they have to ever do in that year group for that unit. If you go down the why route, it just feels like a poorly idealised ego trip; I know how this works, and let's all study it because it's brilliant. It's like, well, actually, what you're doing is completely derailing any sense of what the purpose of the unit is about and what they need to focus on as important. Any confidence built up in being able to use that formula is going to get smashed when you start trying to derive it. There's a very strong argument for some sequences to be front-loaded with the procedure because you want to reduce the cognitive load associated with what they're doing and what they're thinking about. You get that automaticity in place. Then you introduce this complexity of where does this stuff come from? It feels more focused. You want the intent to be, you have to be fluent in this stuff. Not, the purpose of this unit is for you to understand where this came from. That's not really the purpose a lot of the time. It helps in the bigger picture. As I've alluded to, we take students on different journeys and at different points. You can't just go into their environment and ignore their prior experience and go, right, let's go in with the why. It's really complex about where you decide to do it and where you decide to not do it at all and where you decide to strip it back to a rough explanation that helps them understand that this comes from somewhere without going into grassroots deriving stuff from first principles. That comes from just teacher agency. You have to make those decisions yourself based on the class that's in front of you. I can't tell you what to do. All I can tell you to do is justify your own decisions. I think the default, as I said, should be trying to make things make sense particularly if it's Year 7 onwards if you're picking up a Year 7 or 8 group secondary or similar. But don't feel guilty if there are certain units where you do have to just go procedure and fall back on this. It does make sense, but we're short of time, or the explanation for this is really complicated. So I'm going to give you this simple overview. People need to be comfortable with that, but the flip side is don't go all in with we're going to ignore all explanations of understanding and sense-making because it's just easier this way around.

Alison: 31:14

You gave a couple of examples just then about times when it's not appropriate to look at the why first. I'm just reflecting on curriculum design and wondering how those sorts of issues relate to the

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way we design a curriculum for maths right from primary onwards. I'm thinking of some examples in primary that would fit that same category.

Ed: 31:36
I struggled with this and, as per usual, I've changed my opinion over time. When I wrote the book, I thought you shouldn't have anything in the curriculum that you can't explain in terms of making it make sense. Therefore, something like the surface area of a cone or a sphere would probably have to go elsewhere. The difficulty is that even if they were at a point where maths was accessible, it wouldn't be accessible to everyone. You're still going to have the conundrum of some students not likely to understand this to the depth I want, so a compromise will have to be made somewhere.

In a perfect world, yes, the curriculum would just be a sequence of nicely tied-up things that are easy to make sense of in the moment, and the next thing you teach would rely on the thing taught before and so on. But we know it's not as neat and tidy as that, and learning never is anyway. We have to accept that there are going to be points in the curriculum where you aren't going to be able to go into that level of depth, and you're going to have to be comfortable with that. There are ways to make things make some sense without going into too much depth.

You also take away those nice moments at A level where you revisit and figure out more about something learned previously. When you're an employed mathematician further down the line, you don't have all the answers. You're frequently in areas of the great unknown and discovery, dead ends, and confusion. Maybe there's an argument that this is part of the journey of thinking about what it's like to be a mathematician anyway.

Alison: 33:47
It's interesting because, at primary school, we touch on circles, but we don't really look at the formulae around areas and perimeters of circles. Back in the old days, I had A level six group in year six, and I thought, "Goodness me, how do I? I can't remember what I do with these kids about the area of a circle. How do I make it make sense?" I realised I wasn't going to be able to teach them the full why, but I wanted them to have a sense of why it roughly worked.

We did things like put circles into squares and think about the area of the square related to the radius of the circle. We realised that the area would have been four r squared for the square around it. So, we knew the value of pi was less than four, so three and a bit times made some sense. There was a sense of not really knowing exactly why it worked, but if they were ever stuck, they could rationalise why it was going to be the case.

Did you work with other departments across the school? Asking pupils to work or to think about this is leaning into metacognition. Do I really get what's going on here? Can I make this make sense with what I know already? In primary, we have the luxury of one teacher teaching across the curriculum, but when the kids you taught for maths went off to science or history and geography, did you have any cross-department discussions across the whole school around digging for the why?

Ed: 35:45
No, I think in a perfect world, every maths department wants to work closely with the science department as they have the most explicit links with maths. There’s a lot to be said for the benefits of tying stuff together there. But in terms of the general pedagogical approach, no, it's not something I got into.

The one thing that resonated with me was when I used to have this standard speech when I picked up a new class, particularly at Key Stage 4. It would be around expectations—not my

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expectations in terms of behaviour, but in terms of what they want to get out of the lessons and maths and what I want to get out of teaching them. I would always start with just asking them to put their hand up if they hated maths. The few cocky ones would put their hands up almost straight away, and then I would say, "Well, I used to hate it." More hands would start going up, and I would just say, "Right, I don't want to teach you anything yet. I want to talk about that. Let's get to the bottom of why some of you don't want to be here and how I can work with that."

It's all a bit Dawson's Creek, I suppose, but basically—

Andy: 37:12
It's 2023. I'm not sure Dawson's Creek is a relevant reference.

Ed: 37:17
I don't watch TV.

Andy: 37:19
You don't?

Ed: 37:20
I haven't watched TV since the late nineties.

Andy: 37:25
We'll put a link in the notes for anyone who's never heard of Dawson's Creek. It's a wonderful show, everybody.

Ed: 37:31
Where we would get to is, you know, this isn't actually about maths. It's not that they hate maths; it's that they don't feel confident, or they feel more threatened here than in other subjects. Some students feel the same way in art because they're next to someone brilliant and think, "I can't do this, I hate it." You get people in PE who dread it because the person next to them is really athletic. It's not really about maths; it's about confidence and uncertainty and the mental barrier of "I can't do this, and therefore I will never be able to do this."

We get to a point where I say, "Well, I can work with that. I will help you make this make sense and get through those barriers of fear of this subject, but I can only do that if you come to me with this is how I have felt about it, but I'm going to work with you to see what you can do with us." I don't think you can get anywhere with most students—this isn't just a maths thing—without a good culture where it's safe to make a mistake, not know what you're doing, and have an idea that you think is stupid seconds later. Without that, you're going to have a good proportion of your class who are anxious and never going to be confident to try stuff and try to understand stuff. There's this huge barrier of "I can't do it, and as soon as I pop my head up, it's going to be wrong, and I'm going to feel like crap."

The one thing I used to be really strict on was student responses to other student responses. If a pupil said, "I think the answer is three," and another student responded with, "Oh, that's stupid," I would hammer that child because they are destroying the culture. That one offhanded comment they think is funny sets that child back a long way in terms of their confidence to share an idea, thought, or reason. Without that culture, you're up against too many barriers to explore why and explore concepts as a group rather than just me telling you what stuff does.

Andy: 40:34 It has to be a two-way thing. You know, it's like talking to a kindred spirit and maybe that's why we share a birthday. Who knows? You can do everything you want as a teacher, all of the reading, planning, preparing, thinking, and predicting what the students are going to say. But

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unless you've embedded that culture into your classroom from the start as a two-way thing, you're not going to get it. I was so similar to what you've just described, and we've talked about that in season one. I would start with a brand new year seven class, asking who hates maths and why. Let's discuss it. My Twitter handle is desire to understand because that's what I wanted the kids to try and do. Like you've both alluded to, you can't always do that. It's an impossible task to get every single student in every single year group to understand everything, but you have to embed that culture of reasoning. Ask me about it.

When kids are given answers and someone says something daft or mocks someone's answer, I always tried to make them justify their answer. Even if they just said, "I'm just guessing," they've justified why they said their answer. If they give an answer of three, I ask where they got three from. The misconceptions that come out of that answer, if they can justify how they got there, are brilliant teaching points. It's a brilliant discussion to have. If someone in the classroom goes, "What?" you go, "Okay, let's listen to what they've said. Why do you think they got the answer three? What could they have done wrong? If you're so clever and you understand it, what have they done wrong? Can we discuss another example where that might happen?"

Sequencing is a brilliant topic to get an idea of how your students think. Just put random numbers on the board, which in your head are a sequence, and then get them to guess the next term. Why is that the next term? Justify it to me. They can come up with the most wild answers. You go, "Okay, let's go with that. What would the next one be? Actually, the next one was this, so yours wasn't right, but it was working for that sequence." It's that cycle of discovery of maths that I don't know if we get enough time to do in school.

Ed: 43:00 I think you're absolutely right. There's work we can do to develop cultures. For me, it predominantly revolves around having activities where there's no right answer. What I want is your thoughts and reasoning. A really simple one could be putting an array of dots with some kind of pattern but nothing too clear, and you could interpret it in lots of different ways. Just say, "Count the dots for me." Inevitably, they go one by one the first time around. Then you go, "Actually, I don't care how many there are. Forget that answer. Just tell me how you group them." If they group them in ones, that's fine. Then go, "Okay, I grouped them in this really different way," and show them. Bring out another one so they can think about it not as a linear one by one but as a pattern. I don't care what the pattern is, but where is it? How did you see a square or a triangle in here? Everyone has a different thought, everyone has a different idea.

Some teachers might say, "What's the point in that? There's no maths, that's not going to help them with their exam." And in some ways, they're right. But what it is doing is helping to create a safe space where people are willing to share ideas and thoughts. You have to purposefully design some tasks to facilitate that. Otherwise, when you get to those more meaty topics, there's this fear of putting an idea out there because it's going to be wrong. If you've already covered that ground and said, "I don't care if it's wrong. I'm wrong all the time. This is part of what we do here," it makes a difference.

A journey I've struggled with in teaching PGCE students is you can talk to them about great models for explanations, great questioning, and the benefits of mastery. It's easy for them to kill off those ideas because they try it in a class without the culture, and nothing works. They just go, "Well, that was stupid," and roll back to the way they were taught or the traditional teacher model. We need to work on the culture thing.

Andy: 45:53 Too often, year seven parents come to me at parents evening and say, "I don't know what's happened this year. Little so-and-so was so good at maths last year, and now they're struggling." You sit there and want to say, "They were probably good at answering 50 questions having just been taught how to answer that exact question." And that's great, that is a skill to have,

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and we need that skill. We need that willingness to learn and practice and get that fluency. But I don't feel they've ever been asked why before. Suddenly you're putting that pressure on an 11-year-old and saying, "Why? Explain that. Tell me how that's going to work. Here's a different question. Can you answer that one?" You have all the skills you need, but if it looks different, what are you going to do? That has to be part of the culture of students going, "I used to have above my board, I used to make them write on their book, 'desire to understand, maths is problem-solving, problem-solving is thinking, have you thought?'" If you're going to put your hand up straight away and say, "I'm stuck," I always used to say, "Okay, expand. What have you tried?" "I haven't tried anything, I don't know how to do it." "I'll come back to you when you've tried something when you've thought about it when you've discussed it with your partner." Let's get that culture going, that conversation going, that I can work with.

Ed: 47:10 For balance, the flip side is quite common as well. Students are used to talking about maths and exploring ideas in primary, and then they go into secondary and the joy gets sapped out of it because they've got a teacher in year seven who just wants answers. It can be any phase.

Andy: 47:32 Absolutely. That's season one in a nutshell, where I played the role of the arrogant secondary school teacher. I wish I'd had this podcast to listen to when I was starting out teaching. Right, I am conscious of time. We've got some very busy people on this call. I'd like to put you on the spot one last time, Ed. If you're a teacher listening to this, what do you want them to take away? One thing you want them to take away from listening to us for this hour or so and try or think about or develop or ponder over with a cup of tea.

Ed: 48:11 If you've never done this or never emphasised it much, for me, the drug in teaching was trying to figure out how students were thinking about stuff. That never stops being interesting. Lean into that and think about how you can facilitate opportunities to understand how they're thinking about stuff. One of the richest ways to do that is through discourse, through talking to them, giving them time to think deeply about something, and then bringing it back and learning from them about how their understanding is developing on a concept or an idea. Be persistent with that and understand that it takes time to develop. You can't just go, "Oh, that sounds like a nice idea. I'm going to try it on Tuesday." You're not going to come out of Tuesday going, "Perfect. I should do that all the time now." You're going to come out of Tuesday going, "That was really hard, and there are things I need to do to make this work better." The biggest thing you need for it to work well is time. New ideas take time to develop and install, and they take time for the students to shift their understanding of what your classroom is about. But if you can get to a point where they're willing to share their thoughts and ideas, it is such an interesting environment for a teacher to be in, compared to the old school, "Who's got the answer right? Brilliant. Aren't you good in my class?" That, to me, is just not interesting. If you're disinterested or getting bored of what you're doing, it's not fun anymore. The fun for me is figuring out how their brains are ticking.

Andy: 50:02 Sage on the stage versus guide on the side. It always seems to come back to it. Teachers love being the person at the front, and there's something in us that likes that. But it's about getting yourself out of that mode. Talk to your students, listen to your students, and encourage them to talk to each other because that's where you pick up on little nuggets of all sorts of things that you can run with.

Right, Ed, thank you so much for giving up this time for us. We will be recording another episode with Ed at our MEI conference in a little while. That one will probably come out last in this series. That's going to talk a little bit more about what Ed's doing now and how that's working over the next couple of years. If you're listening to this, thinking, "Why haven't they mentioned anything about Oak stuff?" Well, that's coming in a different podcast. Alison, thank you as ever.

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For those who didn't realise, I disappeared for about 15 minutes. I had massive technical issues, so I'm looking forward to hearing what was talked about in the podcast. Thanks, Alison. It's great to, as always, to...

Alison: 51:08 Just to give an update. The sun has come out in Dorking.

Andy: 51:15 Yeah, the South always gets the sunshine at some point. It's still sunny here. There are clouds which are not just grey, so it's quite good. Ed, thanks. We'll talk to you soon. Alison, talk to you soon as well.

Guys at home, thank you for listening. I hope you've learned something from this. It's another brilliantly insightful chat. Good luck with people who just love maths and want to do the best with everybody with their maths. Enjoy. If you have any questions, please reach out to all three of us. I'm sure Ed would be happy to answer any questions on Twitter as well. I'll link to his wonderful book and his other publications, and his website in the notes. We will catch you again on the next episode of Digging for the Why. Goodbye.

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