Transcript

Digging for the Why – Season 2

Episode 2 – The Power of Puzzles with Catriona Agg

Published: 09 July 2024

Podcast Link Here

Special Guest: Catriona Agg

Andy: 0:17
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 with me is my podcast's far better half, Alison. How are you today?

Alison: 0:30
I'm very well. Thank you for that introduction, Andy. I'm sure I'm not.

Andy: 0:35
Absolutely. And I was also thinking, like, we've recorded one or two of these episodes so far. We're not quite sure what order we're going to put them out in, but we say it's a podcast for maths teachers. It does feel a bit more wide-ranging than that now. It's generally getting into that idea of asking why, not just in maths, teaching and learning, but in all other areas of life. So, it's quite exciting.

For this episode today, we are joined by Catriona Agg. She is a maths teacher and well-known in the maths Twitter world for her awesome geometry puzzles. She also works with a local maths hub and is a workgroup lead looking at developing A level pedagogy. She's also been a workgroup lead for 528 Continuity, which listeners to season one will know is very close to our hearts here at Digging for the Why. Catriona, thank you so much for joining us. How are you today?

Catriona: 1:20
I'm so excited to be here. Thank you for having me on.

Andy: 1:24
That's okay. Now this is a free lesson and a lunchtime, so we're very conscious of stealing your precious time at school. So thank you so much for jumping on. Now we like to start this season with a pretty standard question and see what people come up with. So basically, in the last two weeks, what has happened to make you ask why?

Catriona: 1:43
Right. I'm going to say something that happened yesterday. You can tell I'm really well prepared in my year seven lesson, and I haven't really thought it through yet, so maybe you've got some ideas. We were doing division, but we're trying to do division in slightly more interesting ways than just going through division worksheets. So yesterday's lesson was, is it always the case that if you take a palindrome, so a number that reads the same forwards and backwards, and divide it by 11, you get an integer as the quotient? So we started with four-digit palindromes, like 2772, and they always work, and we were able to show that they would always work in a couple of ways. Then we

moved on to other numbers of digits, and one of my year sevens said something, which was that it works whenever there's an even number of digits but not when there's an odd number of digits. Is that because 11 has two digits the same? And I have no idea what the answer to that question is. It was a bit outside the scope of what I was going to do, which was to make them do loads of divisions.

Andy: 3:06
How good is that though? Alison's just quickly scribbled that down. She's like, oh, resources around that. That sounds like a good little challenge. Yeah. I saw her start

Catriona: 3:13
Yeah. I saw her start writing. It's quite cool, isn't it?

Andy: 3:20
I love that. That's very cool. Yeah.

Alison: 3:21
Yeah, but how cool that your year sevens are searching for reason and searching for meaning, and searching for the, why does that work? Why doesn't it work then? Why might that be? It was just really brilliant, yeah. Mm-Hmm, yeah. That's,

Andy: 3:38
Yeah. Mm-Hmm, yeah and that's what we want, right? Maths is about pattern spotting and things like that and going, oh. Well, I think it might be this and hey, you know what, I might be right. I might be wrong. And if it's wrong, that doesn't matter. That's going to inform my next question that I'm going to ask about what's happening. So that's cool. So what's the plan, Catriona? What's the plan? How are you going to respond to that?

Catriona: 3:57
Well, I mean, I don't really know. I've sort of vaguely been thinking about it but not in enough depth. Because there's a question, isn't there? When he said it, my immediate response was, I don't think so, but I haven't thought about it long enough to be able to come up with an answer. Because I haven't really thought about it that way. What we were doing was, after we'd done all the divisions, actually it was a really good lesson, and it was better than I had expected. You know, sometimes you're like, oh, is this going to work? It actually worked. And I think I'm really lucky to work in a school where that's the kind of thing that appears on our department shared resources, is get them to practice divisions by looking at if every four-digit palindrome is divisible by 11. And so we, we did that and then we, we've been trying to work on working systematically and being a bit sensible in how we go about things. We're trying to build these investigative skills. So, we tried laying it out on a table. That was quite nice because it turns out there are only 90 possible four-digit palindromes.

Once we started trying to write them out systematically, we could come up with the fact there were only 90 because there are 10 that start with 1000, and there are 10 in the 2000s and so on. Then we were able to show from that that if we could make the first column, all the ones that are in the 1000s would be great. If we could show it for all 10 of those, and luckily, because most of them had started trying to be systematic with a smallish one, they had covered most of those, so as a class, we were able to tick off all of those. Everything as you move across a column, sorry, yeah, as you move to the next column across, so as you move from the 1000s to the 2000s, so 1771 to 2771, you're always adding 1001, but we know 1001 is divisible by 11. Because that was the very top left-hand corner that we checked. So we're adding on something we already know is divisible.

So, we were able to kind of reason that, actually, all 90 were going to be divisible. So that was great. Then we started trying to do place value. You know 1771 is one lot of a thousand plus seven lots of a hundred plus seven lots of ten plus one lot of one, and if we simplify that down a bit, we've been doing the distributive property, so we can call that a thousand and one lots of one, plus a hundred and ten lots of, what did I say seven. And a thousand and one, we already know, is divisible by eleven, and so is a hundred and ten, so this is good.

And then we moved on, they were able to do two digits very quickly, because two digits, they'd actually already written down their 11 times table before they started doing division, so that was okay, that was already there. There were three digits they quickly found that sometimes worked and sometimes didn't. But then trying to explain why that didn't work and why five digits were similar, sometimes worked, sometimes didn't, was a bit tricky. And I'd prepared for how we were going to prove that six digits always did work because I think I was in a bit of an always, sometimes, never kind of frame of mind, you know, that question structure. So in my head, I was like, well, we can quickly prove that three digits fall into sometimes. And so what we should focus on is how I'm going to explain that some of them always fall into it because that's hard. And we don't want to write out all the possibilities for six digits. So we're going to have to use the place value approach.

Andy: 7:37
How far did you plan for the lesson to go in your thinking? What were your pre-lesson plans?

Catriona: 7:45
I sort of half planned to do the next thing as well. You know, in my head, I thought maybe this is only going to be half a lesson, maybe they're going to get quite bored of dividing by 11 quite quickly. But they got really into it. I think because there are enough things to try you're probably trying some different numbers to the person next to you. But there are not so many that it seems completely overwhelming. And actually, they liked the fact that we, we filled our entire board with a sort of 10 by nine grid of all the possible palindromes for four digits. So they liked the fact that they could sort of see that it was achievable and they could see the reasoning for four digits. And I think that made the rest seem like it would be achievable. So they got really into it. So it took a whole hour. We got as far as explaining why six worked and showing examples for the others, but that was sort of. I'd plan to end on, okay, six works, what about eight? What about 10 and extend it that way? And then, so I wasn't really prepared for talking about the odd numbers. That's cool. I

Andy: 8:55
That's cool. I mean, my favourite thing in that entire bit is where the kid said, you know, ah, will it work for all even ones and not work for odd ones? And your reply was, I don't know, but you know, we could look into it because it's so easy, isn't it as a maths teacher, to go yes or no? And just kind of go, I've got 11-year-olds, 12-year-olds asking me a question. I don't know the answer to it. Can I admit, I don't know the answer to this? Like, and you've got to have that kind of confidence and humility to go, but you know what? We're all in here doing this maths together. So what I can do is use my experience as a teacher to figure out probably the best direction for us to start searching, but great question. That's go, you know, that ties in so much to what Alison and I have spoken about many, many times, that curiosity, that questioning, you know.

Catriona: 9:45
And not being the learner in your own classroom. I think that's opened up so many interesting discussions with primary-age children who are opening up their whole perception of why they're there. And what I got from that is that those year sevens you're working with have... You know, that they feel that they are part of, they're part of this. They're doing the work. And I think sometimes I've been talking to a couple of teachers recently and saying, you know, who's doing the most work in your lessons? If you're doing the most work, then we've not got something right

here. You know, it should be the pupils, the students that are doing the bulk of the work in this lesson. We are a bit kind of like the blue touch paper and get that thinking going. And it's brilliant. And the other thing I loved was all the links to different areas. Distributive law there is the distributive law. And it's useful to them because it shortcuts things for them. They can apply that in their reasoning, which is really, really exciting. That sounds great.

Andy: 10:41
Yeah. I straight away when you mentioned that, I thought of a Year 9 girl I tutor. We've been working on bringing numerical methods, like the box method for multiplying numbers by splitting them up, and showing her how it's applicable to algebra. She goes, "Oh, what? I can expand brackets using what I did for numbers?" And I'm like, "Oh yeah, that's the whole point. Algebra is numbers; the same rules apply. We have to think about it carefully." When you can sow those seeds in Year 7 and start talking about distributive laws and things like that, and just how we can break things up and look at place value and go, "What does it mean?" You know, let's pull it apart.

I put my little girl's six on Twitter the other day. We were talking about numbers, and she's interested. At school, they're doing up to 20 in Year 1, and I sit here like a frustrated maths teacher, "No, no, don't do things she doesn't need to do. We need to do things in line with what they're doing." She started coming home and talking about tens and ones, and I was like, "Oh, okay, right. Place value is a freebie. Now we can go for it a little bit." She saw a number in the hundreds and asked, "Daddy, what's that number? Four nine one four. What's that?" I said, "Forget the four. What is it?" She said, "91." So she's got the two place values. I said, "This column is just the hundreds." She said, "So 491?" I said, "Yeah." She asked, "What's after that?" I said, "Well, Chloe, let's go crazy." So, I drew place value houses for the thousands and showed it. Her mum asked, "What's that?" There's no interest in maths from her mum's side. I explained, "These are place-value houses; they allow us to see how it works and describe what's happening. This is the thousands house." They thought it was amazing. I was like, "I know." But I need to stop before I ruin the few exciting things she'll find in her future. Sorry, I get carried away with place value constantly in my life.

Catriona: 12:43
Actually, you've reminded me that my favourite thing to teach this year to Year 7 is exploding dots. Have you come across that? It's James Tanton's thing. It's so much fun. It's amazing because it's just place value but with dots and explosions. They love it, and it's incredibly useful. You can use it to start explaining things that happen on different bases. We used it today to model dividing decimals by integers. We tried to explain why the decimal point always stays in the same position in the question and the answer using the traditional bus stop method. They weren't great at explaining why it stays in the same place. They could explain why the answer had to be a certain size but not why the decimal point stays exactly above where it was before, which is fair enough because that is quite hard.

Alison: 13:49
That reminds me of a session in my PGCE. We had a maths tutor who taught all the PGCE students, whether primary, secondary, or whatever, and we were looking at how to teach division. We had something like 748 divided by 4 or divided by 5. It was like, fives into seven, no, hang on. We were dividing by seven, so it was 496 divided by seven. Sevens into four won't go. He said, "But it's ridiculous because that four is really a 400." So there are loads of sevens in 400, but we don't write anything there. I said, "That's because it's like the hundreds column, and there aren't a hundred sevens in four hundred, so you can't write anything there. We've got to take that four and do something else with it." He said, "Oh, I've never thought about it like that." So you can put your place value houses. I always looked at it that way, thinking, how many hundred lots of seven are there in four hundred? There aren't any, so we have to treat that four and do something else with it. That was an eye-opener, and the fact that it was an eye-opener for an experienced ITT lecturer was the first moment where I thought, "Oh, maths, that's interesting." I remember it distinctly. But

yes, where place value fits into the formal method of division is a tricky one. Why has it got to be there?

Catriona: 15:28
It's so true. An algorithm we've been using for so long I've no idea how I first learned it. Maybe I did deeply understand what was going on, but it became so background. When you go back to think about it, you go, "Wait a minute, how am I going to explain this?" Even secondary students have been doing these algorithms for so long that they think, "Of course, you start by lining up the digits. Why would you not do that?" They haven't necessarily thought through why that has to be, because it's become so background.

Andy: 16:11
Absolutely. I've said before on this podcast that at the start of Year 7, I used to put a long multiplication on the board and get the kids to do it. They'd ask, "How do you want us to do it?" "However you want," I'd say. You could see those kids who had been to schools where they were expected to play around with it and come up with different ideas. They'd write two or three things down, explode those numbers, and split them up to 20 and three rather than 23. And then you'd see the ones who go 23 times 47, put zero down and start doing it. You'd ask, "So why have you done that?" They'd look at you, "To get the answer." "Why does that work?" "Because it's right. Is it not right? Have I got it wrong?" "No, you've got it right. I'm just interested in what you know about your actions and why."

The year 9 girl I tutored, we worked on fractions, multiplying mixed numbers, and adding mixed numbers. She had these horrible ones, like seven and three 19ths plus something else. So she's going through this process, "I've got these seven times 19, then add three, do this." The other one was horrible. She did it all, took a few minutes, and got it right. Great maths, really good written methods. I said, "What if we just did seven plus three? We've got 10 whole ones, and then three 19ths plus whatever two 17ths." She did it quickly and asked, "How does that work?" I said, "Let's take it back. Long multiplication or splitting these numbers up, fractions are just numbers. Sometimes you must step back, look at the question and think, 'This way is easier.' You've got to have been encouraged from day one in primary school to do that. Gain your skill set, step back and go, 'What do I do?' That's numeracy. Making younger students numerate. The lessons you started off this podcast talking about division; that's what we need to get into our lessons to get the kids questioning, wondering, curious, putting the teacher on the spot, and making them feel awkward. That's good. That's our classrooms. That's what we want them to be."

Catriona: 18:47
I do think there's a lot about what children think maths is. From their perspective, it can turn into just doing loads of calculations. I have a distinct memory of Year 3, doing formal multiplication for the first time, pages and pages of it. It got to the end of the year, we got our reports, and we were supposed to write a comment. My comment was, "I don't like maths because I have to do multiplying all the time." To me, that was what maths was: sit down and do loads of multiplying. But that isn't what doing maths should look like. We've got to show them what maths actually is. What do we mean by doing mathematics? Part of it is being really fluent so you don't get hung up on how to divide by 11. You can do it quickly and accurately with enough brain power left to think through, "Wait, why is this working? How am I going to generalise this?" Also, "What have I noticed? How could I make this work? What are the limits of this?" The conjecturing side of it. Students need to be exposed to that because they won't come up with it unless we promote it. That's what I try to go for with Year 7. Not that I always get it right. They still end up doing really boring lessons that I haven't planned properly, and afterwards, I think, "Yeah, that didn't work."

Andy: 20:28
We'd all love, and obviously Alison and I don't teach anymore, but we'd all love to have the time to create and think about those lessons ahead of time to go, "I know what I want to do, and we can

make a brilliant lesson here." You don't have time because you've got Year 8, Year 9, Year 10, Year 12, Year 13. It is that compromise about finding the best way of doing something.

Catriona: 20:51
Yeah, and I think also some days I'm in a bad mood, and so a kid might ask a great question, and I'm like, I don't know. And kind of forget about it and move on. You know, I don't want to paint a picture like I'm some magic math teacher who is always doing amazing lessons. So yeah, no, it doesn't always happen, but sometimes it does. And I think it needs to happen enough that the kids kind of know what being a mathematician should look like.

Alison: 21:21
Yeah, I think that's really interesting. I've just been reading a couple of things recently where John Mason was quoted quite a lot. And a couple of things that you've just said really resonated with some of his ideas. One of them talked about mathematical noticing. The lesson you described really shouted out that you knew what you wanted the students to notice. The lesson was planned so they would notice that place value thinking and distributive law could come into it.

That made me think, gosh, when I'm working, so now I don't have a class of my own anymore, but I work with teachers, and I do collaborative planning sessions with them. Again, it's like, what do you want them to see? What do you want them to talk about in this lesson? It was really interesting. The other one that made me think about your experience back in year three is that I think he talks a lot about the difference between working on and working through.

If you're working through a load of examples, you get to the end of it and think, well, I've done those examples; that's fantastic. But what he advocates is this idea of working on mathematics. You could have given them whole pages of dividing numbers by 11, but actually, you didn't. You said we want to think about this. By working on these examples, we can come to a deeper understanding and bring other things.

It was those two things that just, the way you described that lesson, really shouted out. I wonder if there's a sense that even when our heads are full of everything else, perhaps even if the lesson isn't the most inspiring one that we've ever sat in front of there's a way of just keeping those two little things: what am I getting them to notice? Okay, it's a bit of an odd lesson today, but what do I really want them to notice?

Catriona: 23:09
Yeah. And how do I get the idea that we're working on this maths and not just working through it? It's just, yeah.

Alison: 23:10
I'm now thinking back to the contrast between a good lesson and a bad lesson, which were the same lesson. I taught exactly the same lesson, period two and period three, to two different year seven classes last week. It was going to be about division. In the first one, I thought I'd give them some quick numeracy practice, and I wrote up three random questions on the board. But then, in the second one, I just changed the question, so it used the number, so it was some big long number divided by two equals, and then I used the answer to what I knew the answer was going to be because I'd just done it the first period.

This divided by three equals, and then I had them times their final answer by six, so it got back to the beginning. It was the same amount of practice; they still did two divisions and a multiplication. But then you can say, ah, what do you notice? Can you make another set that works? Suddenly it was such a better task and took exactly the same amount of time. It was just so much better because I had that experience of doing it before. Basically, because I put 20 seconds more thought into it rather than just writing up random numbers, it really reminded me that there are such small things you can do. I've been using lots of Don Stewart's resources where the answers

make a pattern, which is amazing for practising arithmetic. It's just a small thing, but it makes a big difference, and they love it and the fact that there's always that extra thing to look for. I love those.

Andy: 24:42
I love those as well. It goes back to that pattern spotting thing: if we can ingrain when they're doing something and it looks like hanging on, that's a bit weird. Miss, why is that doing that? You've won on that 10-minute task. Sometimes you need one student in lessons to ask that question. Then it can filter around the room. Even though you're doing a small task, like you were saying, you had 20 seconds of extra thought for that same task for the second class.

That goes back to the start again when you said this only happened yesterday, and I've not really had time to reflect on it yet. For all teachers listening, that is the most important thing. Find some time, whether it's the drive home, just having a cup of tea when you get back, or you've got your kids to bed, and there's this moment of downtime. Think about what happened in that day. If you can give yourself a few minutes to think about your lessons, it can be so powerful to feed into what happens next time you teach that lesson, or a similar lesson or that class.

Catriona: 25:48
Yeah.

Andy: 25:50
I've been sitting here, and I love listening to you talk about this and what happened in school. But all I can hear in my head is, ask her about the problems, ask her about the problems. I really want to know about your, I don't want to call it obsession, but if you scroll through your Twitter, I think it's close. The geometry problems and puzzles and pictures that you set.

Catriona: 26:16
Yeah.

Andy: 26:17
Where did that come from? I look at them and think, how do you come up with these problems so consistently? They're so much fun and just intriguing. Where's that come from? What in your nature led you down that route?

Catriona: 26:34
Well, the enjoyment I get out of it, I think, is what Alison was describing before about mathematical noticing. I just draw loads of pictures. I've got notebooks full of scribbles and quite a lot of algebra that goes with the scribbles. It's kind of, oh, I wonder what happens if I stack these shapes up in this way. What can you work out? You hope you can find something nice. Often I find something nice and realise later that it's not all that surprising.

I don't have my notebook here, so I can't think off the top of my head, but I think I was doing one recently where it was just a triangle. I realised that this triangle had side lengths that were really nice, like maybe one, two and five as the side lengths of the triangle. Then it contained a 45-degree angle, and I was like, Oh, that's really cool. Then I did a bit more work on it and realised that it wasn't that surprising.

It wasn't one, two or five. But it basically involved stacking two other triangles together. It was not that surprising that it had this nice angle in it. A lot of it is kind of near misses. Then I think, how could I disguise this in a way that would lead someone else to notice this nice thing that I think is quite cool? Most of the puzzles come from, wait a minute, there's this cool fact. For example, an angle drawn anywhere in a circle is going to be the same.

The angle at the circumference is the same anywhere. How could I hide this, like, hide the circle, but in a way that allows you to still somehow deduce that it must be there, and therefore it's there? Two angles are going to be the same when they look like they might be different. Or rotations are quite nice. If you take a shape and then rotate it around, it's still the same shape. How do you hide

that in a way that doesn't make it obvious it is the same shape twice by rubbing out a few lines but not so many lines that someone can't deduce it to go back in.

Yeah, I think it's disguise. I really enjoy that feeling of trying to; I've noticed something, so I'm trying to design a puzzle that will make someone else notice the same thing. Now what normally happens...

Andy: 28:50
Do you bring that into your lessons, then?

Catriona: 28:51
I don't know, like there is a sense of it in what I was describing that you have an idea of what I want them to notice here. Dividing by two and then dividing by three can be undone by multiplying by six. How can I set up a series of questions that will lead them to notice that fact? So yeah, I guess there's the same kind of attitude to it. That's what I enjoy. I love that. It's going to sound really smug and horrible, isn't it?

You know that feeling where you know a secret that no one else knows yet? And then you just sort of watch them as they work it out. I love that.

Andy: 29:30
I used to have that with trig identities in A Level. You'd be working through it on the board and you'd giggle to yourself. The kids would be like, why are you laughing? And it's like, I know what's going to happen. I can see it, and you'll see it. Slowly, it goes around, and they go, oh, there it is. That's it. We've talked about that mathematical kick or whatever you want to call it, that students get. I still get that answering right-angle problems.

We were talking off-air beforehand about right angle competition and how beautiful and difficult those questions are. I still get a kick out of getting those right. Even though I taught maths for 20 years, it's just that challenge and that kind of success that you can feel. When you see it happening, it's like, Oh, I love it. I still love that.

Catriona: 30:16
Yeah. It's exactly that. I get that bit on Twitter because, thankfully, there's a really nice community of people who, if you post a nice-looking picture, will try and solve it with a full picture of all their workings. I think geometry is the absolute perfect thing to do this for because it's pretty, and I like colouring things in. I have some really nice packs of felt-tip pens. One of my year 13 students, as she left, got me a pack of 100 different colours. It's the best present I've ever received from a child. It's so good. So yeah, I love colouring things in. They look really pretty, but also, there are about six different ways to solve the problem. I'll have in my head, "Oh yeah, I can make them notice this and this," and then someone will do it in a completely different way, and you go, "Oh yeah, that's really neat. How did I not spot that?" I really like that. I get a bit of the discovery back because people see it in very different ways. Geometry is very open to that. I can imagine that if you were setting a load of algebra problems, there wouldn't be as many different methods to do it. But when you see something and think, "How did I miss it?" there's a bit of a mathematical thrill there, isn't there? Like, "I'm kicking myself now. How did I not see that was a possible way to do this?"

Andy: 31:40
Do you ever use them with a good year 11 class? Throw them up there.

Catriona: 31:45
Oh, do you know what? I don't, but I do have a really good year 11 class at the moment. Maybe I should. Maybe I'll use them a bit with A level classes, but generally with tweaks so that it's more specific. There's a really nice one I've used teaching vectors where they get lots of practice using vectors, but then, at the end of it, they find all their vectors have one particular form. And then that's a definite, "Wait a minute, why did that happen?" I show them the puzzle and non-vector

ways of solving the puzzle that the whole thing's been based on, which is quite fun. But yeah, they're not always the easiest thing to fit in.

Andy: 32:33
Yeah, especially since you lose so much of that fun geometry at A-level, even though you want that A-level thinking and understanding and the willingness that they've chosen A-level maths. But actually, there isn't much fun geometry to be had that's overly relevant in the curriculum. Whereas at GCSE, you can have all sorts of fun with it.

Catriona: 32:55
It is a bit of a shame that there's so much less geometry, but I do think that's about the only reason they work on Twitter. It's one of those things that people can reason a lot about, but you don't learn hundreds of shortcuts in lessons. It doesn't feel like school maths. I think that's partly because it does drop out of the curriculum fairly early on. It's not like solving a load of equations where you'd sort of feel like, "Oh, this is like doing stuff we did at school." It's my feeling. I think that's part of the reason they're so popular: you don't need a high level of education to get into them, but you do need a high level of reasoning, which makes them quite fun.

Andy: 33:42
Oh, Alison, you are muted, by the way.

Alison: 33:46
They don't look off-putting, I think, your puzzles. I come across them on Twitter and think, "Ooh, it's one of Catriona's puzzles. I like the look of that." You've drawn it yourself, and it's beautifully coloured, and it looks really appealing. It looks like the sort of thing I want to get into. Sometimes, people put up something that looks like it's come from an exam paper, and immediately, there's that bit of maths anxiety that comes back. "Oh, it's an exam question. I'm going to have to solve this." It's really interesting. I really liked the way you were talking about designing them because you want to lead them to notice something.

Catriona: 34:17
I've been thinking quite a lot about this and have had lots of discussions with different people about what sorts of problem-solving and being an efficient problem-solver are. We were talking the other day about the number of times I've said to children, "Just have a think about it," and then realised that I don't actually know if they've got the mathematics to think about it. I really like this idea of designing lessons and tasks for them to do where we want some maths to fall out of it, and we want them to notice this is here. We want them to realise they can apply this understanding and this understanding and, therefore, get to an answer. I think sometimes we see problem-solving in primary as either being a word problem that wraps up the maths I've just taught you or something really interesting from over here, random and very large, that involves listing a lot of things. Sometimes it's finding that middle ground where I've actually wrapped up in a problem some understanding of fractions and how they relate to ratio that I want you to spot that you can use those two understandings here. That's maybe something I need to think about: how do we design those problems that force that attempt, force them to notice, or are designed to allow them to notice that.

Catriona: 35:50
I've been rereading Colin Foster's things about mathematical études recently and trying to think about that. My A-level pedagogy group has been looking at this. When you find a really good task like that, where they get lots of practice, but in the course of their practice, they're working towards a higher mathematical goal, they're gold, aren't they? But then, when you sit down and try to design them, it's really hard. It's such a skill to be able to write good tasks like that. But you're right; there's such a payoff. Students need loads of practice. I was a bit worried that my students spent an hour yesterday only dividing by 11, but I think they probably did get enough practice using the division algorithm, given that they have seen it before. Some of them are pretending

they've never seen it before. I know they've all seen it before. I've seen their SAT scores. They have all seen it before. But they also get that larger sense of being mathematicians and like there's something to achieve out of it. So yeah, I do think that point there. Exactly.

Andy: 36:57
That's the difference, right? Between the year three, Catriona, who's like, "Oh, maths is just multiplying." But hopefully, those year sevens are leaving, and you get home and ask, "How was maths?" "Oh, it was great. We were just looking at dividing by 11. Did you know that if you've got a four-digit palindrome..." Then there's this enthusiasm. Next lesson they're going to look forward to maths again. It might be one of those lessons you described as more boring or whatever, but you still got that buy-in. There's still that, "Yeah, but no, maths is cool. I did this last week. It was brilliant. I can't wait to do that kind of thing again." As long as you sprinkle a little bit of that in as often as possible, it's golden. That is what all our lessons need to be like, or should be like, or hopefully could be like again if we have time. That's what you need, what you want from those students.

Catriona: 37:50
Yeah. Doing it once in a while is okay, isn't it? You don't have to be 100 percent all the time. Doing it a little bit is actually fine.

Andy: 38:02
I taught in a couple of private schools at the end of my career. You had more freedom than in some of the states we taught in, but you were expected that the students would get good results. You had to be focused on, "How are you going to get a grade nine in your GCSE? This is what you're going to have to do." But it also meant we could go, "Every half term, can we just have a problem-solving lesson for every Key Stage 3 class?" We could do that because we could work a bit quicker through things we needed to. It was great. Even if it was only once every six weeks, you knew you were getting this stuff into them throughout Key Stage 3, which was great. We tried to do it further, but it became more difficult. It doesn't have to be every lesson, just anything. I think, as Alison alluded to earlier, the key thing is in those lessons, that first year seven one you did where you did the same lesson twice, and it was a bit rubbish. The immediacy, even if you haven't planned, is one of the key strengths of good teaching: reacting to what's happening, reacting to what the students are doing, the questions they might have. We can hopefully adapt the lesson on the fly to follow them and their curiosity.

This isn't part of any questions we think about ahead of time, but it's got me thinking about post-pandemic stuff. I taught a little after the pandemic, and I felt the year 11s I'd had in year 10, then kept them on in year 11, were much better at learning on their own after the pandemic. It had worked, isn't the right word, but it had worked for them in the sense they'd got the chance to test themselves and think about it. I also really noticed that my year sevens that came into the school were my form and were not like, in inverted commas, normal year sevens. They were, they hadn't finished primary school. What's the kind of knock-on effect now on how students learn? So, that year, what would they be now? Year nines? What are they like as a year group compared to, say, the year sevens now that Come back to some normality with primary school?

Catriona: 40:26
That's such a good question. Is there a difference in how they learn? Because it's something I haven't really thought about for a couple of years. Like it's, it was such a focus for, for that first year, obviously, when we came back, and everything was different, and you had your tape on the floor that you were never allowed to cross that line and, you know, like break times at ridiculous times so that different year groups never met each other. And then it's sort of. It's scaled right back so that all of the external signs of COVID are now gone from the school, other than occasional kids missing it. And so I just haven't thought about it. So, the honest answer is, I don't really know. I could tell you how our year nine cohort is generally different to the year seven cohort, but I've

never really stopped to think about how much of that is affected by the fact that, as you say, they never finished primary school.

Andy: 41:16
Yeah. Yeah, and I'm sorry, you know, sorry to throw that on you. I don't know if, Alison, anything's cropped up in the primary work that you do that has looked into it at all and what effect it's had on some of those younger learners.

Alison: 41:29
I mean, well, the prioritisation curriculum is looking at how we cope with these children with gaps. I think there, you know, there are still teachers I work with who say, oh gosh, they do still have gaps. I think one of the key age groups is the very young, our youngest children, so children are going, starting early years now. Who, or maybe the ones in Key Stage 1, certainly missed out on some really vital socialising and socialising experiences? And I was talking to a, in an infant school, and they were saying that their reception classes are really difficult this year because they, they feel, even now, they, you know, they're sort of, You know, we're a couple of years out of it, but they, they missed all the early stuff. They didn't go to the toddler groups. They didn't go through all the snatching things off each other. At a point, you know, being sort of that sort of stuff was missing. And so there's still a lot of backfilling going on. So there are still gaps. I think, I think you know, they. relatively resilient. I'm thinking about mine, who missed out on quite a lot of the upper end of key stage three before I went back and did, and it was the first year of actually taking GCSEs. And to be honest, I'm not sure; I've nothing to compare it to, but he seems to have made a fairly decent transition on into A level study and doesn't seem too, too traumatised by it. I would say the one thing is that they've found and developed other ways of communicating.

Alison: 43:00
older students, I think, you know, he spends all his waking hours at home communicating with friends online. That level of communication has changed dramatically, but there is still work going on at key stage two. And I think, particularly at younger ages, how it's impacted on our youngest. learners in school with the fact that they're learning, not only having to learn a curriculum but that whole social and personal development has been quite severely impacted for some of them.

Andy: 43:32
I saw it when I went to our sports day for reception last year, and I was talking to the guy who goes in and does PE there. And I was like, you know, my daughter's fairly sporty and, you know, just never stops. So she can run, she can do gymnastics, and all that kind of stuff. And I was saying to him, you know, out of the 20 odd kids in the class, a good half of them, I don't really understand how to run, like, and I was saying to him, is that is it normal? Like, you know, this is obviously the first sport I've ever been to with five-year-olds. Is this a normal thing? And he was like, don't forget, they've not done sport for a year and a half, unless, unless their family have taken them to do stuff, they've not done any. So those, that coordination, that agility, that balance. Isn't there for a whole load of them? And I was like, God, I hadn't thought about that in my head. I started thinking about the maths that's been missed. And that's a natural thing to think about, but you don't think of the other side of it. And, and like you say there, you know, those kids who have a three-year-old and he's going through snatching everything phase, and that's fine. Cause he's at nursery, and that's what it's all about. But of course, you'll have five-year-olds who didn't go to the nursery in that phase and didn't go to those, you know, preschool things and stuff like that. Yeah, it's just. Wide range, you know, and you know, that's not on our normal questions, but it just kind of struck me as you know, with Catriona being in school and Seeing it day to day. I just wondered what effect it might be having. Maybe that's a whole let me that's season three. Maybe we can look at, you know, three years after the pandemic, season three of digging for the why. What's happening in our classrooms? I am Conscious of time I, as I always say, around this point of the recording, and I don't want to take up all of your free period and your lunchtime, so there are a couple of questions that I'm interested to just kind of finish with, and I'm going to ask him in a slightly reversed order to what we sometimes do this was I think it was a quote kind of or something that

Allison heard at something and somebody said people don't become Truly independent learners until their postgraduates Now that struck us as Really? Because, you know what, we've seen primary school kids and three-year-olds who are completely independent learners, and that's the whole thing. I wonder what your thoughts are on that, Catriona? In a secondary school environment, you know, you must have kids who are independent learners. If they are, what do they look like? You know, what makes an independent learner as a teenager?

Catriona: 45:55
I mean, I find that so I find it very interesting. I suspect that whoever said it presumably has quite a different idea of what being an independent learner means.

Alison: 46:07
It was in a university context. And they were talking about the fact that, as they saw their students coming through, they didn't become truly independent learners until they got engaged in postgraduate study. And I happened to be in this discussion. We were, I can't remember quite what we were doing. And I said they're quite independent in early years. And there was a sort of tumbleweed moment. And so that head question is, what do we do? Why do we, where does it go from year one onwards? I do think potentially in early years that they get more independence in the sense of the only thing I can think in which this kind of comment, the context of it must be in terms of directing their own curriculum, you know, all the way through. School, like certainly secondary school and undergrad study, the curriculum's directed for you. You know, somebody tells you what it is that you've got to learn and what you're going to be examined on, and that kind of becomes your focus. And I can see that postgraduate study is much more about building your own curriculum, but I think you're right, possibly, right? Early years, there's a certain amount of that as well. There's not a sense of, right, you're going to learn this and then this and then this, and here's the next small step. There is a bit more freedom to kind of. I guess play,

Andy: 47:48
Yeah, yeah, yeah. I always think we can create situations in class, and you've talked about it a little bit already on this, where you are creating that independence because you're giving them that opportunity to explore. And I've, I've often talked about the bowling alley with the bumpers on. You know where you want them to get to at the end of the lesson, you're the bumpers, so you're just making them go down the right path, but there's enough space for them to bump around and explore and things like that. And I think that you are absolutely getting independent learners, aren't you? If you, if you're getting that kind of questioning and thinking and your year seven lesson with dividing by 11, well, does it work for this? I mean, how is that not an independent learner? Kids are asking those questions.

Alison: 48:31
Yeah, I think that, I think what you said about, How do we define independent learning? I think that's really, that's really interesting because maybe we can't give them the freedom that they have in early years where, yes, there is a curriculum, and we are aiming to get them to a certain point by the end of it, but there's this wonderful balance that we try to achieve of self, of child-initiated as opposed to adult initiated. And I think you're right, we, the adult initiated become the whole thing or can seem to become the whole thing and but yeah, lessons like the one you described give back some control to the, to the pupils, and they feel, you know, kind of where they, where they're going, but they've got that. They're definitely the bowling ball travelling down and having the freedom to move. Yeah. Yeah, and

Catriona: 49:17
teenagers, teenagers learn all kinds of things like that, don't they? Just not necessarily the things in lessons. And so, I guess it kind of depends on what you decide counts as acceptable learning and whether it's, you know, it's not always what's in school. Teenagers are very independent learners. About some things that they can't learn in school, you know, they go and teach themselves. So, yeah.

Andy: 49:39
Absolutely. Well, there are a whole bunch of teenagers moving behind Catriona at the moment, which must mean its lunchtime. So, we'll, we'll wrap this up. Thank you so much. What, what would be? You know, if you're a maths teacher listening to this, and we always like to think of what, what's the takeaway for them, you know, like we've done a good lesson plan here, we've got an idea, we want to take something away. What would be your takeaway that you you'd hope people would get from listening to this Catriona? I know what mine would be, but I'm going to put you on the spot

Catriona: 50:06
I really should have thought this through so that I could do it in a nice, pithy way.

Andy: 50:15
It wouldn't be digging for the why in that stance.

Catriona: 50:18
Oh, I could give you a soundbite, couldn't I? I think it's that, the more thought you put into a lesson, the more the students are likely to get out of it. And ideally what they get out of it is in addition to whatever kind of focused learning objective you have that you want them to practice. They also, maybe not every lesson, but over the course of, you know, a year, they get a sense of what maths is. And so building in something that allows them to kind of be a mathematician for a bit. And see what that looks like in the course of doing what you do anyway, which I think you can achieve with, you know, like some small tweaks to little tasks, like making a pattern in the answers actually can have a big effect like that. Sorry, that wasn't pithy at all, was it? That was about as far from a soundbite as I could have got.

Andy: 51:16
That was great. I thought it was wonderful. Alison, is there anything else from you? Before we finish, is there anything you want to ask?

Alison: 51:21
No, I'd just like to come and be one of your year sevens, Catriona, at some point. That would be really lovely. I'd love to take part in a lesson. A little MEI trip to your school to come and look at maths education. No, no, really good. Thank you.

Andy: 51:35
I will put links to everything that's been mentioned, some of those activities and the people. And I'll link to people's Twitters here so you can go see Catriona's puzzles if you've not seen them. And if you want to shout out or reach out to us, then please do. Thank you so much again, free periods are not great to give up, so we really, really appreciate you doing that for us. You can go and enjoy your lunchtime hopefully before now.

Catriona: 51:58
And before I go, can I ask you what your takeaway was?

Andy: 52:02
It was the idea of kind of what you said about your puzzles, and I think if people can plan something which Kind of, even though it's a simple thing, but you're undoing something, you're peeling back the layers, if you like, to reach this kind of thing. I think that's something you could get into lessons. And I think it comes from the same thing you said about giving yourself time to plan something, even if it's just the starter. You know, the thing that you want to get going in that lesson. Divided by two, then divided by three, and all of a sudden, you're multiplying by six. What does that mean? And it's the same, you know, you're not spending any more time on some, a small task, but you're getting more out of it because the student gets more out of it. And I think for me, that is, that's, that's the thing that reflection, that thinking about next time I do this, this would be really good if I did this, you know, because like we've said throughout this podcast, you can't

have. Outstanding lessons every single time. It's impossible. You know, you can, you can spend hours planning lessons. This happened to me loads of times, thinking it was perfect. And then the kids walk in, and they're tired, and they're upset. They're wet. It's windy. Right. Well, that's gone out the window. You know, we just survived the lesson and start again next time. And that's teaching, right? It's the beauty of it and the frustration of it all in one thing. Okay. Thank you so much again. Thank you for listening at home. I hope you got as much out of that as we did here. And we'll be back for another episode of digging for the why at some point soon, we look forward to hearing from you. so much for listening. See you again soon.