Transcript of In conversation with Dr Kristen Tripet

In conversation with Dr Kristen Tripet – 33:27 min

Jackie – Good afternoon everyone and welcome to In Conversation. My name is Jackie Blue and I'm really excited to be hosting this session today. I'm joined by the leader of professional learning for the New South Wales mathematics strategy, Michelle Tregoning.

Michelle – Hi everybody!

Jackie – and the Primary Mathematics Coordinator Ayesha Ali Khan.

Ayesha – Hello everyone!

Jackie – as well as several of our leaders in mathematics education who will say hello in the chat space this afternoon and we encourage you to do the same.

We begin by acknowledging the many beautiful lands that we are gathered on today across NSW. We acknowledge the traditional custodians of each of these lands and pay our respect to Elders past, present and emerging and extend our respect to any Aboriginal or Torres Strait Islander participants this afternoon. I'm joining you from the land of the Dharug and Eora peoples. Please share with us who is joining from your device this afternoon in the chat and we'd love you to share the traditional lands where you're joining us from as well.

So, we're absolutely thrilled to be joined by Doctor Kristen Tripet. Kristen is the program manager of Resolve Maths by Inquiry the flagship maths education program at the Australian Academy of Science. With a lifelong interest in mathematics, Kristen has worked as a primary school teacher, and a mathematics education consultant, before commencing her work with Resolve. Kristen is an active member of mathematics Education Research Group of Australasia or MERGA and is a Fellow of the International Society of Design and Development in Education and serves for them on their executive committee. She's also involved in state and national reference groups, and expert advisory panels in mathematics education. In 2019, Kristen completed her Doctor of Education in mathematics education through the University of Sydney. So, let's jump straight into it this afternoon.

This is In Conversation with Doctor Kristen Tripet. Welcome, Kristen.

Kristen – Thank you. It's great to be here with you all.

Jackie – Thank you. And just by way of introduction, I'm absolutely in awe of anyone with a PhD, so we'd actually love it if you would just tell us a little bit about yourself to kick us off about your education and teaching background, and maybe even a little bit about your PhD.

Kristen – Sure, look as you've already said I work at the Australian Academy of Science as the director of the ReSolve: Maths by Inquiry Project. My background is primary school teaching. Always had a real love of maths, but not school maths. Quite often at school there were times I loved it, but probably more often than not I hated it. Found it quite boring and when I went into education there was no way I was going to be a maths teacher and so going into education I actually realised I could change the way maths was taught in schools, and that's when I went into consultancy and I was in Sydney and from there came down to Canberra and worked for the ReSolve program and now am running the program.

My doctorate I completed a couple of years ago now through Sydney Uni and again it was another thing I sort of fell into. I hadn't sort of planned it and it just happened that I was able to do it. And I looked at a learning progression or learning trajectory for multi digit multiplication. I felt it was an area that was very under researched and in looking at the learning trajectory I coordinated both the social and cognitive aspects of learning and sort of what came out is very significant, was the role of representation and discourse in developing students understanding but an important thing just at this point in time is my research was based on the theoretical perspective of realistic mathematics education, which is a theory of mathematics education from the Netherlands, and they base their work on this idea of mathematising and you'll be familiar that the Australian curriculum has been released even though you know NSW has their own syllabus, it's really worth reviewing the curriculum still, the Australian curriculum. And the notion of mathematising that is making sense of the world mathematically, is now acknowledged in the curriculum. Something I'm very passionate about and really excited to see. So yeah, that's me!

Jackie – Well, welcome we're really thrilled to have you with us this afternoon and excited to hear from you about some really important concepts in maths. So many different researchers talk about big ideas in mathematics, Kristen, we know that they are important and that different research talks about them in different ways, just based on the different areas of maths that they're exploring.

We know that big ideas connect aspects of mathematics together. Peter Sullivan once said that reasoning is the glue that holds mathematics together, which to us sounds an awful lot like a big idea. So, we know this is a focus and passion of yours and the ReSolve project, and we wondered if you could talk with us a little bit more about reasoning, why is it the glue and what makes it a big idea? And actually, what is it?

Kristen – Yeah, look, saying before that my PhD I was looking at this notion of mathematising and in some sense mathematising and reasoning are almost the same. It's that making sense of the world mathematically, making sense of things, and in our curriculum, I'm using here the Australian curriculum, that's what ReSolve is based on, a similar description or identical description in the New South Wales syllabus.

It's this idea of analysing, proving, evaluating, explaining, inferring, justifying, generalising, and what you can see is these are reasoning is about cognitive actions, things that happen in your head, but you also externalise it, that is that you talk about it, you have to justify things. That it's verbal. It's also written. And so, we talk about discourse as being both verbal and written, so it's this process of external discourse but this internal work going on, which I'll talk about again in a second. I'm going to talk a little bit more later on about some of the work that ReSolve has done, the project that I work on in reasoning, but very quickly they talk about three things that we analyse, we generalise, we justify, and that cycle continues of analysing, generalising, justifying, and I think that's a really helpful way to think about reasoning. The three things that we really need to do. But one other thing that I think is really important with reasoning is that reasoning and sense making go hand in hand, and that this idea of sense making or understanding really making sense, that moment you go, "Ah. I get it!, I can see what is happening", is that process of sensemaking and once you get it, that's when you can reason mathematically using logical clear arguments. And so, it's really important to think of the two together.

[Reasoning is the process of manipulating and analysing objects, representations, diagrams, symbols, or statements to draw conclusions based on evidence or assumptions. Sense making is the process of understanding ideas and concepts in order to correctly identify, describe, explain and apply them. Genuine sense making makes mathematical ideas “feel” clear, logical, valid, or obvious.]

Why is it the glue?

[Reasoning is the glue in mathematics ‘In mathematics, adaptive reasoning is the glue that holds everything together, the lodestar that guides learning. Kilpatrick 2001, p19

Reasoning and sense-making are critical in mathematics because students who genuinely make sense of mathematical ideas can apply them in problem solving and unfamiliar situations and can use them as a foundation for future learning. Battista 2017, p6]

Peter talked about it as the glue and that came from some work out of the United States. A document called, "Adding it up" and that was the Peter's work around the proficiencies came from that document and Jeremy Kilpatrick talked about it in this document, "Adding it up", that adaptive reasoning is that glue that holds everything in mathematics together that lodestar or guiding star that guides all learning, and I think that's really important.

I was talking to some schools in the ACT last week at a conference they were having and they talked about the proficiencies and we talked about fluency as often the most misunderstood. I think that is so true, but I would say that reasoning is the one that is done probably the least in a lot of classrooms, and yet it holds everything together. And that's a huge challenge for us as teachers and what it means.

Michael Battista, who if you ever see any of his work, it's really worth reading, again from the United States, talks about reasoning and sense making together and he says they are critical in mathematics because those students who can reason and truly understand they're the ones that apply. And this is where we talk about students who are not fluent. They’re often, they're the ones that can't apply, that might be able to recall but they can't apply. And they use strategies, procedures for problem solving and use them to build future learning. So, it is the glue, and yeah, as I said, I think it's often done poorly in classrooms because we're not quite sure what it is, what it looks like, what it sounds like, what it feels like.

Jackie – So what sorts of tasks and experiences can promote reasoning in our classrooms, Kristen, and what's one of your favourite experiences or one or two of your favourite experiences and why?

Kristen – The sorts of tasks yeah, they're they actually talk about, so again, I keep going to documents that are out of the United States. They've got some fantastic work in mathematics education, another document they've got is called Principles to Actions, and in that document, they talk about 8 effective teaching practices. What is it that makes an effective teacher of mathematics? And they talk about tasks that promote reasoning and problem solving, and those sorts of tasks are those tasks that are that higher-level cognitive demand.

[Low-level demands

Memorisation

- Reproducing facts, rules, formulas or definitions with no connection to underlying meaning
- Cannot be solved using procedures, because
  - The procedure does not exist, or
  - The time offered is too short
- Not ambiguous

Procedures without connections

- The use of a procedure is specifically called for
- Little ambiguity
- No connection to meaning that underlies the procedure
- Focus on correct amswer, rather than developing mathematical understanding
- No explanation required

High-level demands

Doing mathematics

- Requires complex and non-algorithmic thinking

- Requires exploration and understanding of mathematical concepts, processes or relationships
- Requires considerable cognitive effort
- Requires students to analyse the task and examine constraints that may limit the solution or strategies.

Procedures with connections

- Attention on purpose of procedure and understanding of mathematical concepts
- Suggest pathway to follow that is connected to conceptual idea
- Represented in multiple ways
- Requires cognitive effort

Stein and Stein 1998]

So Smith and Stein again, United States talked about a framework of different tasks, how they fit into a cognitive demand framework, and they said those with lower level demands, they're memorisation sorts of tasks, procedures without connections. They offer little opportunity for reasoning in the classroom. Now I want to say at this point there's a place for these tasks in the classroom and I'll talk about that more so I don't want to say all we should do is this higher-level cognitive demand, but I'll talk about it a bit more.

These high cognitive demands are doing mathematics tasks and procedures with connections and they're the tasks that get me excited when you see them and they're the tasks as well that allow students to reason and problem solve.

[Tasks that promote reasoning

Student learning is greatest in classrooms where the tasks consistently encourage high-level student thinking and reasoning and least in classrooms where the tasks are routinely procedural in nature. Bolar and Staples 2008, Hiebert and Wearne 1993, Stein and Lane 1996]

And probably most importantly, that research shows us they are the tasks where learning is greatest. So often have, or you hear, teachers say they take so much time to do, well they're the tasks that are actually worth doing, and so we need to do more of this, less of that repetitive work, however, there's a place for that sort of work in consolidating those skills, So we often talk about inquiry or problem solving or explicit teaching and they actually go hand in hand. we're not talking about two different styles, but I use these tasks that promote reasoning and problem solving to introduce mathematical ideas, to explore those ideas, and then we learn through them rather than using them at the end, for example.

So, some of my favourite tasks, look these are two ReSolve tasks (they're going to be resolved tasks).

[Slide shows 10 cards, first card says 10, next says +9, then +8, down to +1. Text says Use addition and subtraction so the sum is 27. Use addition and subtraction so the sum is 15. Use addition and subtraction so the sum is 12.]

These are probably two of my favourite sequences that are on the ReSolve site. It was actually I wanted to put in about 3 or 4 but we don't have that time today, but this first one is the 2nd in a sequence in Year 4 and I won't tell you what it's on just yet because that will give the game away, but it's called 10 to 1 and the idea is that these are flip tiles with instead of you can see there the plus 9 tile, if you flip it over in the tiles we have there's a subtract 9, so the idea is that you flip between addition and subtraction on these tiles so that the sequence adds to 27.

At the moment that sequence, I think, adds to 33, so, if you think I've got to take six off, it's interesting a lot of kids will then subtract the 6. What they find is hang on a second. I'm now 12 less, what's going on? So some nice reasoning happening just there, but they make 27. They make 15 and then a couple of them think they've made 12 and we're able to show them that actually they can't, and that making 12 is impossible, and then the challenge becomes, "Why is it impossible and not make 12?" "Why can't you make 12?" and it comes down to an understanding of odd and even numbers, and this is where the reasoning really comes in. Why is it that you can't make 12?

It's the sense making process that goes on and the reasoning, so, any even number can be represented as pairs. 2a, if we're going to do it algebraically, any odd number is a pair plus one or 2a + 1. Now if I think about that in terms of what happens when I add those numbers together, an even plus an even number, will always give me an even and even plus an odd will give me an odd. But then an odd and an odd, those two odds joined together to make an even and you get an odd and an odd will always give me an even and so you then look at these guys, oh sorry, who you know this, children saying, and this is reasoning I have heard from students when they talk about, "Oh, an even number of odds will always give me an even because the odd pair parts pair up." Or "An odd number of odds will always be odd because the odd parts don't pair up."

Now if we go back to our 10 to 1 sequence we've got in there an odd number of odds. Therefore, it is always going to be impossible to make an even number. Another beautiful piece of reasoning I heard from a student was what we can actually do is start to break this down. It goes even not even odd. And we compare those up and all of those will add to an odd, but then if we pair, the odds that we get an even and slowly go down, you start joining all of these together you get, you will only ever end up with an odd answer, so that's reasoning I've heard from you for students which really made sense to them and to their classmates as we talked about it. It helps us make sense of or we can ask questions about well, what about multiplication? It just takes you lots of different places.

Approximation, so if I'm thinking I've got to mentally add two 2-digit numbers, if I know in my head there's an even and odd then I know I should get an odd answer. Those sorts of things come in, talk about patterns in long number sequences, so Fibonacci pattern. It always goes odd, odd, even, odd, odd, even, odd, odd, even. Why is that? We can actually explain why. We can look at Pascal's Triangle and think of it as odd and even numbers and then make sense of Seren Pinsky's triangle which gives us beautiful patterns and fractals. So, you start to make like that reasoning. It goes deep, you're making sense, and I actually think it's the pleasurable part of mathematics as well.

My other one and I know I've got to speed up, but my other one of my favourite tasks is this idea of factor strings. So, again, deep reasoning happening. This task is part of a sequence at Year 7. So, we asked students to search the puzzle for strings of factors that multiply to give 480 XXX FROM 18:00 XXXand two of them are there and the students explore that for a while. They start coming up with some and we start collecting them and we can ask some other questions like, "Well, can you use a string of three factors to make a string of five factors?" And we've got a string down there 16, 3 and 10 give me 480. Can I use that to make five? Well, 16 and 16 is 4 + 4, ah, Sorry 4 times 4 is 16, ah the factors of 16 is 4 and 4. The factors of 10 include 2 and 5 and then I've got my three. So yes, I can use a string of three to help me find a string of five, and kids explore, "Can we use four factors to make a string of three?" What about the numbers in the grid that can't be used at all and we stop and say, "Well 204 is not a factor of 480, so I won't try to use that. Same with 51, with 44 and also with 29." And then we ask the question, "Well, what's interesting about the strings as they get longer apart from the numbers getting smaller, what's an interesting observation about these numbers about the properties of these numbers?" And so, we ask the kids to find the longest string that they can, and how can you prove that you cannot find a string that is longer?

And this is where we go into the notion of prime factorisation that the longer the strings get, the more prime numbers are in those strings and they're the numbers that we can't factorise any further and it helps students too. And this is where you see a lot of sense making going on for kids because I think now I'm sure I can get a different way if I break these numbers down in a different way, but they realise that every number can be represented as a product of primes in exactly one way or any number greater than one, which also helps us understand why one is not prime, because if one was prime then I could represent any number in an infinite number of ways, because I can just continually multiply by 1? And so, then we go into factor trees and we look at breaking down these numbers. Can you actually find a factor string that's different? A prime factorisation string that is different and kids see, no, they're always identical. It doesn't matter how I break it down, it will always be the same. And what's interesting then about prime factorisation is we can then use that to reason more deeply about numbers. We can look at a string of prime factors, so these are our prime dice, two kids playing a game of prime dice, a lot like Yahtzee, I won't go into it now, but rolling that first child there, the little boy he's got 3 fives and a seven. So, the prime factors of 5 to the power of 3 times 7 and I can say about that number is that it's odd. I know that that number is odd because it doesn't have two as a prime factor, and then when I look at that second one I've got 3 squared times 5 squared. I know that that number, without actually knowing what the number is, it's a perfect square because of the prime factorisation. It also helps us to identify using 2 numbers What's the highest common factor? What's the lowest common multiple? and so that's unpacked through the course of these lessons, but the reasoning that the students were involved in is really deep. So sorry, that was long, but two of my favourite ReSolve tasks and really deep reasoning with the students going on.

Jackie – Please don't apologise. Really enjoyable tasks because I had to actually restrain myself from picking up a pen and paper and doing that first challenge.

Kristen – surely I can make it!"

Jackie – I guess that's the whole, the whole thing, isn't it? When we're trying to establish that that environment where our kids are being doers, and sense makers of maths themselves, we need to have those feelings too, right?

Kristen – Yeah, exactly, exactly.

Jackie – It's definitely worthwhile having a play and I've popped the link in the chat for you if you're interested about where you can find those ReSolve tasks so, well, I guess then the next kind of question, Kristen, is how do we know when we're seeing that good reasoning from our students? And how do we actually teach it while we're using those tasks?

Kristen – I think they are key questions to what it is that makes a fantastic teacher of mathematics. Good reasoning in the class is logical. We often talk about mathematics being logical, reasoning needs to be logical. It is really clear, good reasoning, it's clear, it is easy to follow, and I think the other thing is, it's mathematically complete. It's not only mathematically sound, but it's complete and you sort of wrap up a problem with a really deep understanding is that process of analysing, forming generalisations and then justifying those generalisations,

So it is more than just the how, but it's the why and I'll give an example there. We often, for example, in the primary classroom, primary teachers on the whole are so good at asking their kids, "How did you work that out?" Secondary teachers as well. I see this more in primary just because we're often talking about where they're given 2 numbers to add or multiply, whatever it might be. How did you work it out? And the students talk through how they work it out, but the teacher doesn't ask the follow up question, which I think is even more important. Why did you do it that way? So, I can solve 7 + 8 by saying it's the same as 7 + 7 + 1 and I did it that way because I know my doubles, where as a child might say I did 7 + 7 + 1 because that's what you told me to do. And that's not reasoning.

So, it's being able to say the how, how you went about and did something, the why you did it and why mathematically it works that way. It's based on that mathematical structure.

In ReSolve we talk about classrooms that have a culture of reasoning and sense-making, we talk about them together. So how do we teach it? It's through the culture of the classroom, first of all, I think it's really important, that this is expected of students. That this is what is normal in a mathematics lesson that we're verbalising, not just the how but the why, and explaining our thinking, how it fits together. And that we really need to be making sense of the mathematics we're studying.

That means as teachers, it's not so much sitting down saying to kids, "This is how you reason." But this is how I think as teachers, to build classrooms that have this culture of sense making and reasoning, these are the actions that a teacher will take, that actually will have a greater impact than saying to kids, "This is how we reason."

You need to have really clear mathematical goals for your lessons that are based on understanding and not skills. So, if I'm going into a classroom to just build skills, I'm not going to be able to reason mathematically necessarily about the structure of mathematics, so base it on understandings and skills, are, one thing I will say is true fluency is built through reasoning, not through sitting down doing lots of practice. And use those understandings to focus your teaching and have in your mind, "What are the acceptable forms of reasoning that you expect as the teacher to hear from the students?"

So, that means you need to know the problems, you need to have worked them through - like, like Jackie, you wanted to sit down and do that problem then you need to do it, like, you need to sit down as a teacher and do it.

And what do I expect to hear from the kids?

And you're going to hear unexpected things as well and think well, you know, is it mathematically sound? Students must be allowed to construct meaning for themselves, so that is not, and this is something I am a big believer in, that's not giving them concrete materials and telling them how to use the concrete materials. For example, I'll use you know, middle primary, let's you say about Year 3, Year 4, we're going to add or subtract two 2-digit numbers. Here's your MAB, this is how it works.

You're trying to make sense on behalf of the students using a representation that makes sense to you. But unfortunately, often that representation does not make sense to students. It will make sense to some but not others, and so students need to be allowed time to construct their meaning for themselves.

And so, as a teacher, one of the best things you can do is give your class time and to really make sense, and your role there is to guide students to prompt them, to question them, as they really engage in the sense making process and then orchestrate those opportunities for really rich mathematical discourse and that is, you know teacher to student, student to student but also whole class and that's really important knowing that mathematical discourse is both written and verbal.

Quiet maths classrooms are not reasoning classrooms.

I thought I'd share really quickly just my own recent experience, I was in a maths workshop the other week where I got to sit down and do some maths with some mathematicians from University of Adelaide. First time I have done some maths like that for a while and in it they asked me, they asked the question I was working with my colleagues here on the question and it wasn't a complex question in many ways, but we had to reason as to why something worked the way it did, and I, in my head, it made sense, sort of, and I was articulating it and working with this mathematician who really pushed me and we were talking. And then I suddenly realised it wasn't completely clear in my own head. And so, I had to spend a bit more time on paper. And that sense making process happened for me on my own, I needed to actually move away from the group at that point, and then it really made sense. And then I was like, "I've got it." I can explain it really clearly, logically and completely and it was really good for me to be in that position because we need to experience what it would be like for our students.

Jackie – So, question of the hour...

Kristen – Yeah?

Jackie – Should we assess it? Should we assess reasoning, Kristen, and if so, how? How would we do that?

Kristen – Look, controversially, I would say throw out any other sort of assessment and just assess reasoning.

Yeah, you cannot not assess reasoning because reasoning is assessing understanding. It's assessing students' fluency. It is assessing their ability to problem solve. It is assessing everything.

How do you assess reasoning?

Well, ReSolve has done a large project, and I must say at this point I wasn't involved in this work. it was, you know, the University of Deacon, Deacon University down in Victoria did this work for ReSolve and you can find it on the ReSolve website.

I'll give you the web address later. But they talk about how we can assess analysing, so they use a rubric. This is an abbreviated form of the rubric [Image of 3 arrows (analysing, generalising, and justifying) with spirals circling them individually next to ta table…]. How you assess analysing, generalising, and justifying using that rubric, and they go through students' worked examples so they give different tasks that use reasoning, and then they show students worked examples.

I think we need to get video, we'd love to get video of kids verbal reasoning as well, we haven't got that as yet, but it shows how reasoning can be reliably assessed, and yes, so that's on there and they focus on tasks from Year 3 to 6. That doesn't mean you can only assess reasoning in Year 3 to 6, you should be assessing reasoning from kindergarten to Year 12, and the same rubric and ideas can be used.

They also give some fantastic prompts, so if we are asking, I talked before about asking questions and prompting students in the classroom. These are some helpful ideas for really exploring what it is students are doing in terms of analysing where they're at, in terms of generalising and in terms of their justification. And so, these [refers to mathematical reasoning prompts on PowerPoint] are helpful to guide your preparation of questions. A good teacher will always prepare questions before a lesson and they will be focused on those key understandings we're trying to develop.

So again, that's in the assessing reasoning work from Deakin University, that is on the ReSolve website, all freely accessible. And the ReSolve website, for those of you that don't know it, along with those tasks I mentioned, everything is free, thank you to the Australian Government Department of Education, Services and Employment, at resolve.edu.au. You can access it there.

Jackie – And you're welcome everybody because you're about to disappear down a rabbit hole of resources.

Kristen – There's some great stuff there and

Jackie – I must say a huge thank you for giving us your time this afternoon, Kristen, it's been a pleasure as always and again it's just all about that, sparking that joy for mathematics through these really, really important, significant ways of learning.

Kristen – And I don't think there could be anything more enjoyable than going, "A-ha! I've got it. I really made sense!" and being able to verbalise that and share that with others.

Jackie – I think we'll wrap it up there.

Thank you very much for your time.

Thanks everybody for joining us for In Conversation and join us in a few weeks' time. We'll release the information on MyPL for our next session.

Thank you.

[End of transcript]