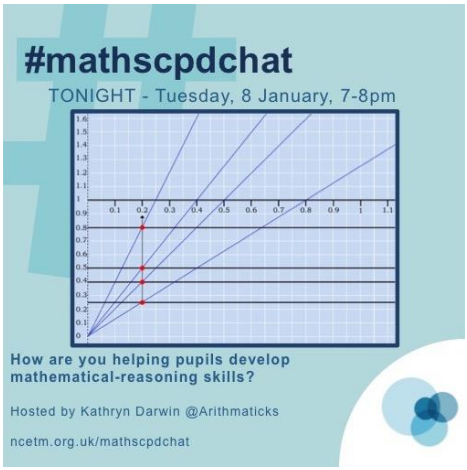
National Centre for Excellence in the Teaching of Mathematics

#mathscpdchat 8 January 2019

How are you helping pupils develop mathematical reasoning skills?
Hosted by @Arithmaticks

This is a brief summary of the discussion – to see all the tweets, follow the hashtag ***#mathscpdchat*** *in Twitter*



Some of the areas where discussion focussed were:

- the primary **National Curriculum** is light/vague on both the detail and progression in mathematical reasoning;
- whether or not skills of mathematical reasoning can be **explicitly taught**;
- teaching reasoning by **example and non-example** … demonstrate sound reasoning, expose unsound reasoning, and discuss the difference;
- reasoning and solving problems being **key elements of all lessons** … 'reasoning is so often about 'going deeper' (using a teaching for mastery approach)';
- pupils **being able to explain** is key … 'the 'why' is the most important part of a solution' … justification leading to proof;
- silent individual thinking/constructing explanations … followed by in pairs sharing/discussing … then **whole-class sharing of explanations**;

- pupils with more developed reasoning skills can themselves **deduce some mathematical facts** without being explicitly taught (told) them;
- struggles to teach pupils to **reason geometrically**;
- **visual proofs** … eg any proof by conguence can be translated into a proof by transformation;
- various tasks to support pupils in **early stages** of learning to apply geometric reasoning … eg using similarity, congruence, rotation …;
- how what we mean by 'mathematical reasoning' **changes as pupils learn** … 'as you gain knowledge in mathematics you can reason in new/different ways';
- reasoning can be **about what doesn't work** … leading eventually to understanding proof by contradiction … understanding counter examples;
- reasoning in mathematics as **logical reasoning** … understanding implications, 'ifs', 'only ifs', etc;
- using **2-way 'larger, same, smaller' tables** to reason about connected mathematical ideas;
- understanding and using mathematical **inverse**;
- developing fluency with numerical properties and relationships … **using 'arithmetical structure'**;
- how **embracing all aspects of 'Variation Theory'** supports the development of reasoning skills;
- developing a **'scheme of learning'** with the focus on showing/describing/exemplifying progression in mathematical reasoning skills;
- key questions and sentence stems to probe thinking … eg 'can you find a way to solve this that no one else has?' … having a display of such prompts in your classroom … expressing the same problem in different ways.

An interesting 'conversation' of tweets, about how evidence that pupils are reasoning mathematically, and what is involved in their learning to do it, changes and develops over time, followed from this tweet by Kathryn Darwin:

including these from Martyn Yeo and Kathryn Darwin:

Martyn @martynyeouk · 15h

Replying to @Arithmaticks

I reckon reasoning is the same thing throughout school life, but is taught in different ways. In the same way that addition changes so does reasoning?

Kathryn @Arithmaticks · 15h

I think I would agree - as you gain knowledge in mathematics you can reason in different ways... Can you perhaps give an example of the way it would change over the years in your context? #mathscpdchat

Martyn @martynyeouk · 15h

To start with its very simple reasoning with children explaining what they notice about things e.g. 3 sweets are less than 5. Then progresses into pattern spotting before moving onto systematic approach...#mathscpdchat

Kathryn @Arithmaticks · 15h

Lovely! I think the explanation is key - the 'why' is the most important part of a solution in my classroom. Sometimes I stop one student mid explanation, and ask another WHY they did that, or WHY it would help to get the answer etc.

this from Simon Gregg:

Simon Gregg @Simon_Gregg · 16h

Replying to @Arithmaticks

Hi, just dipping in! #mathscpdchat https:// There are some really good games and puzzles where reasoning is to the fore. Sudoku is great, as is @KenKenPuzzle. Also Guess Who, and Mastrermind, which I play with a simplified version.

Simon Gregg @Simon_Gregg

Y4 Mastermind: Thinking about how we know what we know. y4atist.blogspot.fr/2015/10/how-do… @TracyZager @woutgeo @BridgetDunbar

and these from Martyn Yeo and Kathryn Darwin:

Martyn @martynyeouk · 16h

Replying to @Arithmaticks

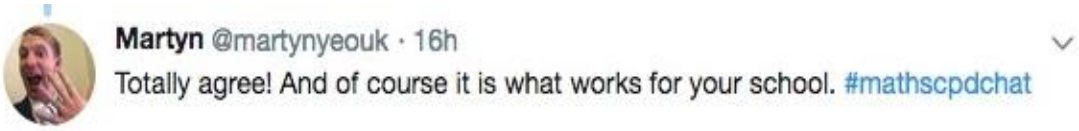
Well maybe that is what I need to write! A scheme to ensure progression of reasoning! #mathscpdchat

Kathryn @Arithmaticks · 16h

Would LOVE to see something like that implemented through a SoL! Do you think non-specialists would benefit from something like this? #mathsCPDchat

Martyn @martynyeouk · 16h

Definitely - in primary there is not always the time to think about every subject in depth. Im sure there are other restrictions in secondary, but a scheme can be a good starting point



(to read the discussion-sequence generated by any tweet look at the 'replies' to that tweet)

Among the links shared were:

Reasoning: Identifying Opportunities, which is an article written by the NRICH Primary Team in 2014; the team discuss when reasoning may be needed in the problem-solving process both to highlight how reasoning is the 'glue' that helps mathematics make sense and also to help us refine our understanding of what we mean by the term reasoning. It was shared by Kathryn Darwin

Reasoning: the Journey from Novice to Expert, which is also an article written by the NRICH Primary Team in 2014; the team look at how developing excellence in reasoning with young learners is a complex matter, involving thinking about the reasoning itself and understanding the progression in that, as well as thinking about how we are going to support children to develop the communication of their reasoning. It was shared by KandMMathsHub

Where's the reasoning?, which is a blog published in October 2018 by Herts for Learning in which the team 'flesh-out' what is stated in the 2013 National Curriculum about reasoning mathematically, shared by Primary Maths

Reasoning: Where to start?, which is a guest blog published in October 2018 by Herts for Learning in which Lucy Wilson, maths subject leader at Wheatfields Junior School in St Albans shares how she and her team successfully improved children's ability to reason mathematically, shared by Primary Maths

Questioning Template which is a collection of example questions (categorized in a 2-way table) that might be asked to support pupils' learning including their ability to reason mathematically, shared by Primary Maths

Algebraic area Reasoning Tasks which is a TES resource consisting of several tasks designed to improve students' mathematical reasoning, shared by Primary Maths

Glow Hub Variation resources which is a page of the Glow Maths Hub website from which you can download resources developed by the Glow Maths Hub's group of teachers (Acoustic Variation POWWOW) who worked with Anne Watson to understand and communicate effective teaching strategies associated with 'Variation Theory', shared by Steve L

How do we know? which is a blog by Simon Gregg about using games, such as 'Mastermind' to help develop the reasoning skills of young learners, shared by Simon Gregg

It Stands to Reason 126 which is an article in the NCETM's Secondary Magazine 126 about how developing pupils' abilities to imagine and recognise rotations helps pupils to reason geometrically, shared by Mary Pardoe

It Stands to Reason 130 which is an article in the NCETM's Secondary Magazine 130 about reasoning involving mathematical similarity, shared by Mary Pardoe

It Stands to Reason 129 which is an article in the NCETM's Secondary Magazine 129 about reasoning involving mathematical inverse, shared by Mary Pardoe

It Stands to Reason 127 which is an article in the NCETM's Secondary Magazine 127 about reasoning involving the arithmetical structure of relationships between factors and multiples, shared by Mary Pardoe

It Stands to Reason 128 which is a continuation of the article in the NCETM's Secondary Magazine 127 about reasoning involving the arithmetical structure of relationships between factors and multiples, shared by Mary Pardoe

It Stands to Reason 131 which is an article in the NCETM's Secondary Magazine 131 about how a particular kind of two-way-grid-of-cells can be used to stimulate reasoning about related quantifiable concepts, shared by Mary Pardoe