What do we want children to show us?

- Encourage children to make connections with prior learning and draw upon secure mathematical content.
- Children to use a range of contexts to trial their ideas.
- Children to present their thinking using a range of representations – images, equations and concrete resources.
- Encourage children to express diverse thinking including questioning and challenge each other to interrogate ideas and develop resilience.

How can we move children forward?

- Use a reasoning scale (see example) to assess children's current level.
- Provide sentence openers for the next step on the scale, model these and expect children to use them.
- Select activities which lend themselves to a higher level of oral reasoning.

References:

Boaler, J (2019) Prove it to me! Available at: https://joboaler.org/wp-content/uploads/2022/04/prove-it-to-me-JB-copy.pdf

Nrich (2021) Reasoning: The Journey from Novice to Expert. Available at: https://nrich.maths.org/11336

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Reasoning: the Journey from Novice to Expert (Based on an article from Nrich https://nrich.maths.org/11336)

	Language examples			Pupil 1	Pupil 2	Pupil 3
	Beginning	Developing	Securing			
Step 1 Describing	Simply tells what they did.					
	I did… I put… I saw… No words but showing with manipulatives / pointing. Overuse of pronouns	No logical approach or justification I picked… I got… I thought… I found… Firstly… then … finally	The pattern looks like… All the numbers begin with… I noticed… At first, I… Then, I…. After that, I…			
Step 2 Explaining	Offers some reasons for what they did. These may or may not be correct. The argument may yet not hang together coherently.					
	No link to previous learning Uses manipulatives to show answer but incorrect reasoning.	I tried this, but… I thought this, but… I used this to get that… We thought it would be best to…	I realised… We started off by thinking about… We could… but…			
Step 3 Convincing	Confident that their chain of reasoning is right and may use words such as, 'I reckon' or 'without doubt'. The underlying mathematical argument may or may not be accurate yet is likely to have more coherence and completeness than the explaining stage.					
	I know… I know because… Links to previous learning and models Links to working wall: I can see… so…	It must be… It has to be… I reckon… Without doubt… I already know this so… I know that… so…	I think… I reckon… I started with… because…			
Step 4 Justifying	A correct logical argument that has a complete chain of reasoning to it and uses words such as 'because', 'therefore', 'and so', 'that leads to'…					
	With encouragement makes links with more than one representational context.	Because… Therefore… And so… That leads to…	… So … …, therefore, I know…			
Step 5 Proving	A watertight argument that is mathematically sound, often based on generalisations and underlying structure.					
	Children will expect to be asked to show their thinking in different ways rather than being prompted. Making connections across contexts to support answer	Proving through diagrams / drawings Trying different strategies. I already know this, so… There's no other way because…	… therefore, I can deduce / predict…			

NCETM Reasoning Skills. Available at: https://www.ncetm.org.uk/classroom-resources/pm-reasoning-skills/

Russo (2018) Mathematical Proofs in Primary Schools. Available at: https://www.researchgate.net/publication/324861008_Mathematical_proofs_in_primary_schools

Research and Innovation Work Group: Oracy

What Does Proof Look Like in a Primary Classroom?

This guide was written by work group participants in response to their personal research.

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Who is proof for?

You may think that proof is for the teacher to assess the level of understanding, but it is far more valuable than this. Proof equips children with a transferrable skill set allowing them to:

- Articulate ideas to form a watertight argument.
- Develop the skill of challenging a concept or idea.
- Apply their knowledge in different contexts.
- Develop self-belief and the confidence to question or probe the ideas of others.
- Create a mathematical mindset, fostering a sense of value and mathematical purpose.

"Pupils had greater autonomy when forming their argument."

(Work group participant)

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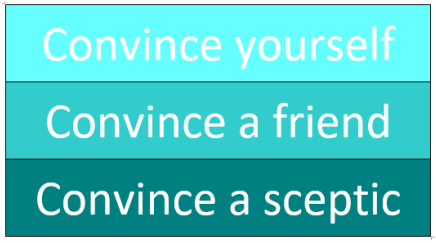
"Using proving activities has ensured that the teachers' skillset and knowledge has developed."

(Work group participant)

What does the teacher need to do?

Schools need to embrace diversity of thinking, implementing a culture of challenging pupil's mathematical ideas. They should recognise that maths isn't always about an answer, but a process of exploration. Vocabulary, sentence openers and stem sentences should be taught explicitly, providing consistent and frequent opportunities to practise these skills. Teachers should value the use of manipulatives, representations and the abstract in equal measure.

It is essential to establish a culture in the classroom built on enjoyment, a willingness to explore, challenge and collaborate with others.



Using a convincing framework (Boaler, 2019) provided a supportive framework for children to develop their reasoning skills: "the easiest level of persuasion is to convince oneself."

How can we design opportunities for proof?

- Recognise that proof is part of a reasoning continuum which promotes high order thinking.
- Reduce cognitive load as it will allow oral reasoning to flourish.
- Use Nrich Primary Curriculum Map, NCETM Progression in Reasoning and Jo Boalar's Convincing Framework as a start point for planning.
- Prepare probing questions to stimulate language and thought.
- Encourage children to build on each other's ideas.

What do we want children to say?

We want our children to have the confidence and the skills to articulate their thinking and reasoning. By having the following skill set they will have the ability to challenge and support others in their thinking.

- Use sentence openers to construct their answers (see image on cover)
- Speak in full sentences, elaborating their thinking through the use of precise mathematical language.
- Draw on prior knowledge, make connections and give other possibilities when explaining.
- Challenge and support peers, adhering to agreed protocols.
- Be able to agree, disagree or explain alternative thinking.