

SHORT READ #3: QUESTIONS TO PROMOTE MATHEMATICAL REASONING

KATHERIN CARTWRIGHT

How do we get students talking about their mathematical thinking? This is a common question that classroom teachers ponder when reflecting on mathematics lessons. Reasoning in mathematics is also a current theme within mathematics education research; proportional reasoning, mathematical reasoning, spatial reasoning, algebraic reasoning and numerical reasoning, just to name a few.

“As many as fifty thousand questions are commonly asked by teachers in a year compared to ten questions asked by students.” Watson and Young (1986), *Discourse for learning in the classroom*

For me, one of the most vital ways to elicit students' mathematical reasoning is through questioning. It is not simply including or asking more questioning itself that is necessary, but specifically designed questions that help in drawing out students' prior knowledge and encourage students to move beyond just explaining what they are doing.

“Coming up with the right question involves vigorously thinking through the problem, investigating it from various angles, turning closed questions into open-ended ones and prioritizing which are the most important questions to get at the heart of the matter.” Katrina Schwartz, “For Students, Why the Question is More Important Than the Answer”

Why do we ask questions?

The [NSW Mathematics K-10 syllabus](#) states that students should “be confident, creative users and communicators of mathematics, able to investigate, represent and interpret situations in their personal and work lives and as active citizens.” This means that students should not only be able to answer questions, but be able to pose questions as well. Having the mathematical knowledge alone is not enough, students need to be able to wonder and question about the mathematics. When students can communicate and talk about what they know, that's when they are truly proficient. Then the mathematics can be applied and explored for a variety of specific purposes. We pose questions to:

- gain insight
- confirm understanding
- extend thinking
- build on prior knowledge
- find gaps and misunderstandings
- develop shared sense making

We don't ask questions to answer them ourselves

Hopefully, as classroom teachers, we don't ask questions to answer them ourselves. We ask questions to provoke student thinking and promote student to student discourse where mathematical ideas are discussed. We may have anticipated certain solutions by students, but our in-the-moment decisions need to be based on student responses that may take us in different directions, not just where we planned to go!

Types of questions

To help guide us in the kinds of questions to ask, we need to think about what we want students to reason about. There is not list of 'best' questions, question-asking is a skill that needs to be developed.

- Answer seeking... 'what is the answer?'
- Knowledge building... 'can you add to what... said?'
- Knowledge proving... 'does it always work?'
- Noticing/ Wondering... 'I wonder when we might use this?'

Often, it's a simple change of the question stem, or thinking more about the learning intention and my expected outcomes to adapt the questions to meet the lesson's purpose. Sometimes I want to ask questions about students' processes and sometimes it's about the mathematics itself. I also thought about how ACARA's [Australian Curriculum: Mathematics](#) defines reasoning and what questions might look like align to that definition.

Questions for reasoning about students' strategies and processes (the how)

How did you go about solving the task?
Where did you start?
Why did you think that was a good strategy?
Why does that work?
Would it work if I changed the numbers?

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Questions for reasoning about students' understanding and solutions (the 'maths')

What did you find out?
What do you notice about the different ways to solve the task?
Are there any patterns?
What do you know about the numbers you are using?
Why did you put the numbers where you did?
What are you using to help you solve the problem?

Another shift I've made is to clarify for students if I want to know what they're 'doing' or if I want to know what they're thinking. Below is the idea I've been playing with that I hope you can utilise in your own classroom.

When students think about themselves communicating what they know, helping them understand whether it's the act of doing ("what I did") or thinking ("what I know") can help. Then the students can also use these stems in their talk, with the aim of moving beyond, "I just thought it", or "My brain just did it"

Moving from 'what you are **doing**' to 'what you are **thinking**'



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From action verbs to thinking and relating verbs

- For mathematical reasoning students need to progress from telling us what's **happening** to telling us what they are **thinking**



- By doing this students are able to make connections, compare and contrast related ideas and transfer knowledge

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