Accelerating Learning in Mathematics

RESOURCE 6: BUILDING UNDERSTANDING THROUGH EFFECTIVE QUESTIONING AND MODELLING

Children are naturally curious and often use questions to voice their curiosity. Place an unopened box in front of the class, and it won't be long before the questions surface: "What's that?", "Can we open it?", "Is it for us?" You can also use questions to evoke curiosity: "What do you think might be inside?"

Eliciting, supporting, and extending student thinking through effective questioning is a skill that requires preparation, practice, and reflection. Modelling thinking aloud helps students to understand the kinds of thinking that solving a problem requires.

This resource discusses different types of questions and suggests ways for teachers to extend their repertoire of questions. It also provides examples of teachers thinking aloud.

Why is this important?

Questions are an important part of many everyday interactions. They are asked to gather information, to self-reflect, to uncover and challenge assumptions, to clarify and confirm listening, to get help. The questions you ask in class should model the type of questions you want your students to ask themselves and each other.

Encouraging students to contribute to discussions shows them that their ideas are valued. But it's important that the feedback students receive goes beyond praise or encouragement. Instead, the focus needs to be on eliciting and responding to student thinking.

Effective teaching uses questions to extend thinking and scaffold instruction rather than to simply ask for an answer. Well-crafted questions help students to think more actively about concepts and processes, to make connections, and to build understanding. **The person who does the thinking does the learning**.

Beliefs underpinning effective teaching of mathematics

- Every student's identity, language, and culture need to be respected and valued.
- Every student has the right to access effective mathematics education.
- Every student can become a successful learner of mathematics.

Ten principles of effective teaching of mathematics

1. An ethic of care
2. Arranging for learning
3. Building on students' thinking
4. Worthwhile mathematical tasks
5. Making connections
6. Assessment for learning
7. Mathematical communication
8. Mathematical language
9. Tools and representations
10. Teacher knowledge.

See *Effective Pedagogy in Mathematics* by G. Anthony and M. Walshaw, Educational Practices Series 19, International Bureau of Education, available at www.ibe.unesco.org

OPEN VERSUS CLOSED QUESTIONS

The questions you ask, and the way that you ask them, should reflect your purpose for asking a question in the first place. Think about the types of questions you might ask to:

- engage an inactive student in a lesson
- check whether a student has mastered a skill
- explore a student's understanding of a strategy
- help a student explore a mathematical relationship or make connections
- build a sense of community within the group or class.

The form of question used influences the type of thinking needed to answer it. Closed questions imply that there is only one correct answer, often a single word. Open questions are used to elicit ideas, processes, and strategies and require a more considered response.

Read these closed versus open questions and reflect on the types of responses or thinking they require:

Do you understand how Mark solved the problem? versus *How did Mark solve the problem?*

Is this statement true? versus *When is this statement true? Why?*

Does anyone have any questions? versus *What would be some good questions to ask?*

PREPARE QUESTIONS IN ADVANCE

Posing questions that stimulate thought is not easy, so preparing questions ahead of time is an important part of planning an effective lesson. Extend your repertoire by using some of the following questions.

Questions to find out what students know

These questions can be used to check whether the student understands the task. They also help the student attend to the information they have access to – information provided within the task or from their prior knowledge or experience.

What is this question asking us to find out?

What information do we have?

What can you see?

Are there any parts of the task that are unclear?

What do you know already that could help you with this problem?

How could you use something that you already know to help you solve this problem?

Questions that provide guidance or hints

Questions can be used to help students make connections and form generalisations. They can also be used to help a student who is stuck find a way forward.

Have you seen a problem like this before? What strategies did you use?

What do you know that can help you here?

How does this task relate to the skills we practised at the start of the lesson?

Can you see a pattern?

Can you draw the problem?

Is there a faster way to work it out?

Are there any special words (or numbers) in this problem that we should be noticing?

What size answer would you expect to get?

Questions to help a student explain their reasoning

Understanding a student's logic (sound or flawed) is the starting point for determining the learning experiences the student needs in order to move forward. For this to happen, the student's thinking needs to be visible. The following questions help a teacher to hear what is happening in a student's mind.

How did you do that?

How did you work it out?

What did you say to yourself?

Can you show me with this equipment or with a drawing?

Questions that require a student to defend their ideas

The small-group setting of an ALiM group is an ideal place for students to participate in mathematical discourse by justifying their ideas in a non-threatening environment.

Can you give me an example?

Will that always work?

How do you know you're right?

What would happen if …

Use these counters to show me that your method works.

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Questions to help a student consider alternative strategies

It's important for students to understand that there may be several ways to approach a problem. This should not devalue the strategies they have employed but rather should encourage them to explore other possibilities or to listen attentively to the ideas of their peers. This shifts the focus from "the answer" to the process used.

Is that the only way to get the answer?

Did anybody else do it that way?

Can you solve the problem in another way?

Is there a faster way to find out?

Questions that position the teacher as co-learner

When working in a small group or with an individual, the teacher can act as a problem solver, who suggests ideas and responds to the suggestions of the students.

I wonder what will happen if …

What strategy could we use to check this?

Will it work if we do it like this?

Can I use the same method to work this one out?

I'm going to test it out. Let me know if I'm getting something wrong.

Questions to help a student reflect

Reflection plays an important role in consolidating learning. A teacher can ask questions to identify whether students recognise the key concepts or strategies the session has been based on. Ideas can then be recorded, for example, by displaying different strategies on the classroom wall or by including them in a learning journal.

What important ideas did we explore today?

What were some different ways that we solved a problem?

What have you learned that you could apply to other problems?

Have you heard an idea today that was important or useful?

Using statements to promote dialogue

Statements can be more useful than questions in promoting dialogue between students. After you have used the questioning techniques outlined, students should be ready to engage in mathematical discussion among themselves. Try introducing some teacher statements along with questions to promote discussion between students:

That's interesting … tell us how you approached the problem.

So you're saying …

Another example would help us understand your working better.

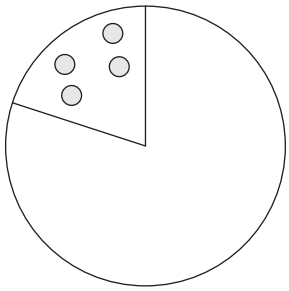
MODEL THINKING ALOUD

"Think-alouds" (Davey, 1983) are used to model thinking processes. By verbalising his or her thoughts, a teacher can model the strategies they use to understand and solve problems. Think-alouds help students to recognise that there are often a number of steps involved in tackling a problem and that answers don't just magically appear.

Examples of strategies that can be modelled include using prior knowledge, drawing a diagram or using equipment, imaging, looking for patterns, and making predictions. The strategies the teacher models should be informed by the learning needs of the students.

For example, a teacher wants a student to see how visualising the size of a share (in this case, a piece of cake) can be used to work out how many shares are needed to make a whole:

> *"Here is a piece of Rongopai's birthday cake. Each piece of cake has the same number of candles. How old is Rongopai?"*
>
> Numeracy Development Projects Book 7, page 27



> *Well, I know that Rongopai's age is the same as the number of candles there were on the whole cake, so that is what I need to work out.*
>
> *First I need to find out how many pieces the cake was cut into. I know what a quarter looks like. It would look like this* (the teacher traces a quarter shape on the circle). *But this piece looks a bit smaller, so there must have been more than four pieces.*
>
> *I can use my finger to trace where each cut was made. I'm estimating where each line would be, using the first piece as a guide, because all the pieces need to be the same size. The first line would be about here* (the teacher traces a line with her finger), *then one here and one here* (tracing two more lines). *Three lines. I can kind of "see" the lines and pieces in my mind. When I count back, there are four "invisible" pieces, plus the one drawn in. Five pieces. Phew! I'll write that down so I don't forget …*

The teacher can ask the student to participate in the think-aloud by asking the student for suggestions. For example:

> *I know that there were five pieces. What shall I do next?*

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REFERENCES AND FURTHER READING

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