Education Scotland
Foghlam Alba

Effective Questioning to Support Assessment in Numeracy & Mathematics (BGE)

For Scotland's learners, with Scotland's educators
Do luchd-ionnsachaidh na h-Alba, le luchd-foghlaim Alba

Contents

Purpose of This Guide

- This guide aims to provide examples of the types of questions that could be embedded in planning, learning, teaching and assessment within Numeracy & Mathematics. It also aims to highlight the specific assessment opportunities within each approach.

- It is not intended that all questioning approaches are used at once. Different approaches can be used at different times and how you use these will depend on the learners you are working with.

- Questioning in Numeracy & Mathematics is not limited to the examples provided. It is recommended that these examples are discussed and built upon through collaborative dialogue in order to meet the needs of individual learners.

Is an integral part in providing high quality learning, teaching and assessment experiences.

Informs planning of next steps for learning.

Provides opportunities for learners to answer in different ways.

Determines what learners know or need to know.

Effective Questioning

Supports the identification of where additional support is required.

Is planned and embedded throughout learning, teaching and assessment.

Promotes discussion and deepen understanding.

Can also be created by learners.

Timing

- Effective questioning takes place at the start of a lesson and should continue throughout.
- Different types of questions will serve different purposes. It is important to consider the purpose of the questions you plan.
- Learners need to be provided with enough time to think about what the question is asking. Try not to take responses too quickly or ask a follow up question too quickly. Providing 'wait' time is very important.

Open Questions in Mathematics

What are they?

- Open-ended questions are framed in such a way that a variety of responses or approaches are possible.
- They can encourage creativity and higher order thinking as learners can use different approaches and materials to find solutions and represent their thinking.

What might they look like?

I am thinking of two numbers that total 5. What numbers could I be thinking of?	I wonder how we could sort these items we have collected?
Early	
What can you tell me about the number 4?	Select 2 shapes. What is the same? What is different?

I have £3.57 in my purse. What coins could I have?	I am thinking of a 2D shape that has 2 lines of symmetry. What shape could I be thinking of?
First	
35 and 45 How are these numbers similar? How are they different?	I measured an item and the answer was 17cm. What could I have measured?

A number has been rounded to make 28.7. What could the number have been?	10 is a fraction of a number. What could the number be? Explain why you chose this number.
Second	
Can you find two angles that add up to make 180°?	Together 3 children have £26.89. What coins or notes might they have each?

You add two fractions and the sum is $\frac{3}{8}$ what could the fractions be?	The solution of an equation is x = 3, what could the equation be?
Third/Fourth	
A dataset has a mean of 7 and a range of 4. What could the dataset be?	One of the angles in a right-angled triangle is 23°. What lengths could the sides of the triangle be?

Assessment opportunities:

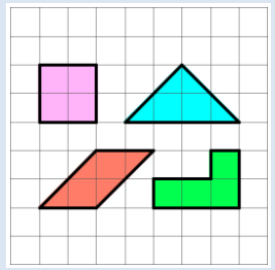
- What approaches does the learner use?
- Is this the most efficient approach?
- What is the learner able to do?
- What should the next steps be?

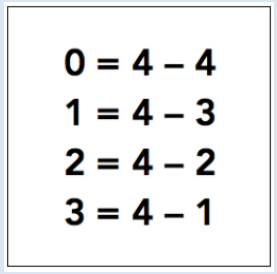
Further reading and additional examples are provided in this miniguide.

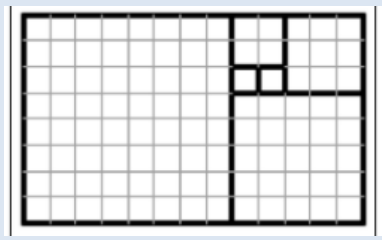
Open Questions in Mathematics

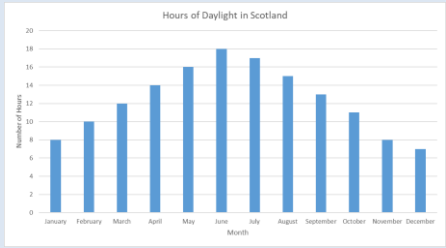
What do you notice?
What do you wonder?

Learners are provided with an image or an item and they are asked 'What do you notice?' No other questions are asked at this point. Provide learners with time to think about what they notice. The more time you provide, the more observations they are likely to make. This approach can allow learners to 'notice' multiple things and can provide opportunities to assess the mathematical observations/connections that learners are able to make. Once time has been taken to 'notice' and make observations, learners could be asked 'what do you wonder?'







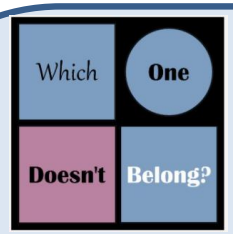


Suitable for all levels. For further information and ideas see:
https://buildingmathematicians.wordpress.com
Creative Math Prompts — 5280 Math
https://slowrevealgraphs.com/

Assessment opportunities

- What observations do learners make?
- How much scaffolding did they require?
- Can they make links between mathematical concepts?
- What prior learning are they processing?
- What conclusions do learners draw?

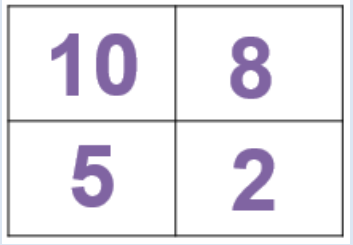
Open Questions in Mathematics

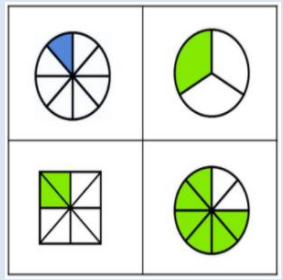


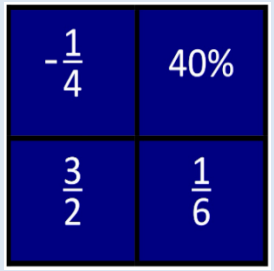
Which One Doesn't Belong?

Learners are provided with four different images or items and have to decide which of the items does not belong to the group and justify why they think it does not belong.

There are many different, correct ways of choosing which one doesn't belong and this type of activity can provide opportunities to assess the mathematical reasoning of your learners.







Suitable for all levels. Many examples available:

https://wodb.ca

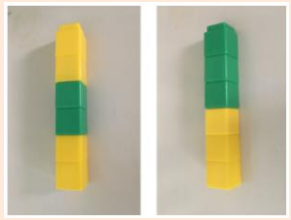
Which One Doesn't Belong (WODB) (meaningfulmathmoments.com)

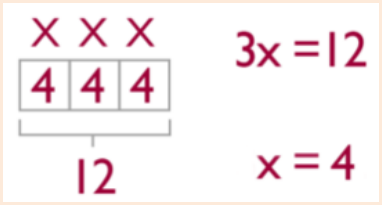
Same But Different

This is an approach where two things are compared, calling attention to both how they are the same and how they are different. It is important to notice the word 'but'. Learners consider how the two items can be both.

When using the 'Same but Different' routine learners are encouraged to look at the features, characteristics and defining qualities of what they are comparing.

This provides opportunities to assess the connections learners are able to make and their mathematical reasoning.





Suitable for all levels. Many examples available:

SAME BUT DIFFERENT MATH

Same Surface Different Depth (SSDD) Questions

The Approach

Originally introduced by Craig Barton (see miniguide.)

They are a series of problems with a similar surface structure but have different levels of complexity or challenge.

What might they look like?

I get a 12% pay rise. I now earn £2000 per month. What was my previous rate of pay?	I get paid £2000 per month. I get a 12% pay rise. What is my rate of pay now?
I buy £2000 in shares. They increase in value by 12% per month for four months. What are my shares worth now?	I buy £2000 in shares. I sell them 12 months later for £2400. What is my percentage profit?

A B C  Which shape does not have one quarter shaded?	One quarter of a number is 10. What is the number?
A baker drops a box of 12 eggs. $\frac{1}{4}$ of the eggs break. How many eggs break?	$\frac{1}{4}$ m = ____ cm

$\frac{1}{4}$

An apple costs 37p in the tuck shop. Show which coins could be used to pay 37p exactly.	An apple costs 37p in the tuck shop. I pay using a 50p coin. How much change will I get?
An apple costs 37p in the tuck shop. You only have 20p. How much extra do you need to buy the apple?	An apple costs 37p in the tuck shop. How many apples could you buy for £1.

Assessment opportunities:

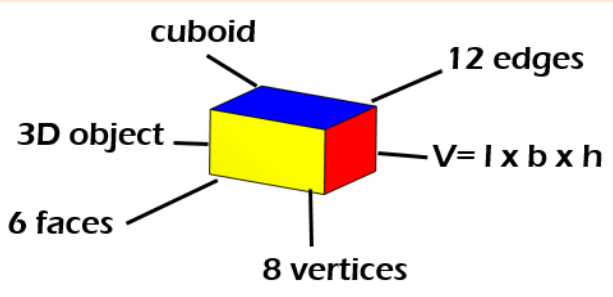
Can the learners:

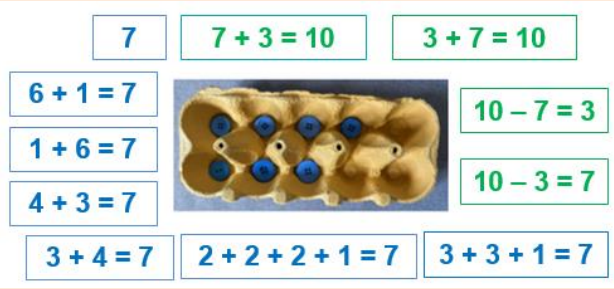
- identify the correct strategy?
- use the strategy to answer the question/solve the problem?

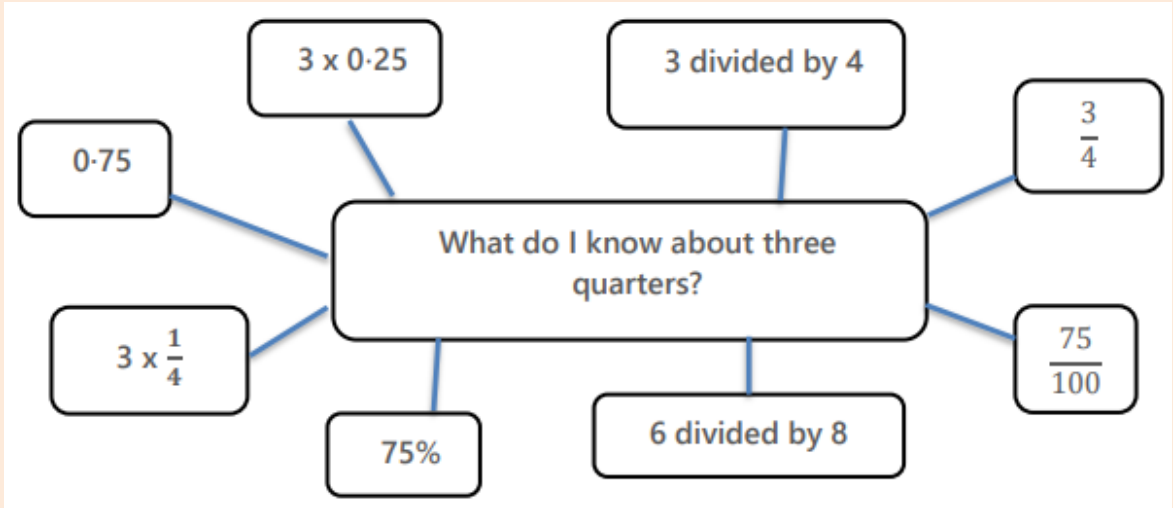
What Else Do You Know?

Learners are provided with a mathematical representation e.g. a number, a calculation, an object or an image. They are then asked to note down what they know about it. You can keep asking them 'What else do you know?' until they have no more ideas. This approach can extend learners' thinking and assesses what they know and are able to do.

This approach is similar to 'Here is the Answer, What is the Question'. Where learners are provided with the solution and they are asked to create potential questions.







Suitable for all levels.

Assessment opportunities:

- What connections have the learners made?
- Are there any misconceptions that need addressed?
- Are there any gaps in learning?

Here is the Answer. What is the Question?

5

Potential questions, learners might create:

- What is 3 add 2?
- What is half of 10?
- What is 25 ÷ 5?
- How many faces does a square based pyramid have?
- What is one quarter of 20?
- What is x if 6x = 30?
- What is -8 + 13?
- A worded problem.

Similar to the 'What Else do you Know' approach, learners are provided with an answer to an unknown question. This could be a mathematical representation e.g. a number, a calculation, an object or an image. They are then asked to create a question or questions that could create this answer.

This approach can be extended by adding in additional conditions such as:

- Can you think of another question that would give the same answer?
- Can you think of a more challenging question that would give this answer?

Suitable for all levels.

Assessment opportunities:

- What connections have the learners made?
- Are there any misconceptions that need addressed?
- Are there any gaps in learning?

Diagnostic Multiple Choice Questions

Assessment opportunities:

- Which learners need further input?
- Are there any misconceptions that need addressed?
- How does this impact on next steps in learning?

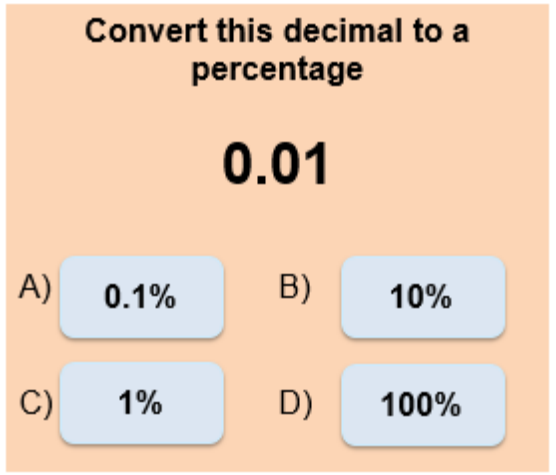
Further reading and additional examples are provided in this miniguide.

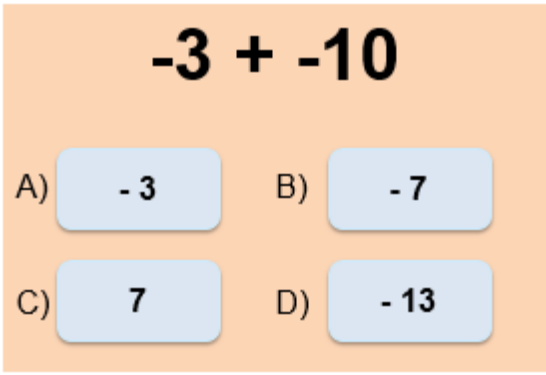
Diagnostic multiple choice questions (DMCQs) are designed in a way to help you as a practitioner check for understanding, or for misconceptions in learning.

Although traditionally used at the start of new topics to assess what learners already know, they may also be a useful tool as learners progress through current topics.

Questions and distractor options in DMCQs should be constructed in a way that it is clear whether or not learners have understood what has being taught, or what misconception they might have. The distractor options should be based on known common misconceptions. It is important to give quick, corrective feedback on any misconceptions identified.

A 'second-tier' in DMCQs can be to ask learners to explain why they have chosen a particular answer, or to offer a choice from a bank of common correct (or incorrect) reasons.





Hinge Questions

A hinge question is planned for during a lesson to identify whether learners have understood the main concept.

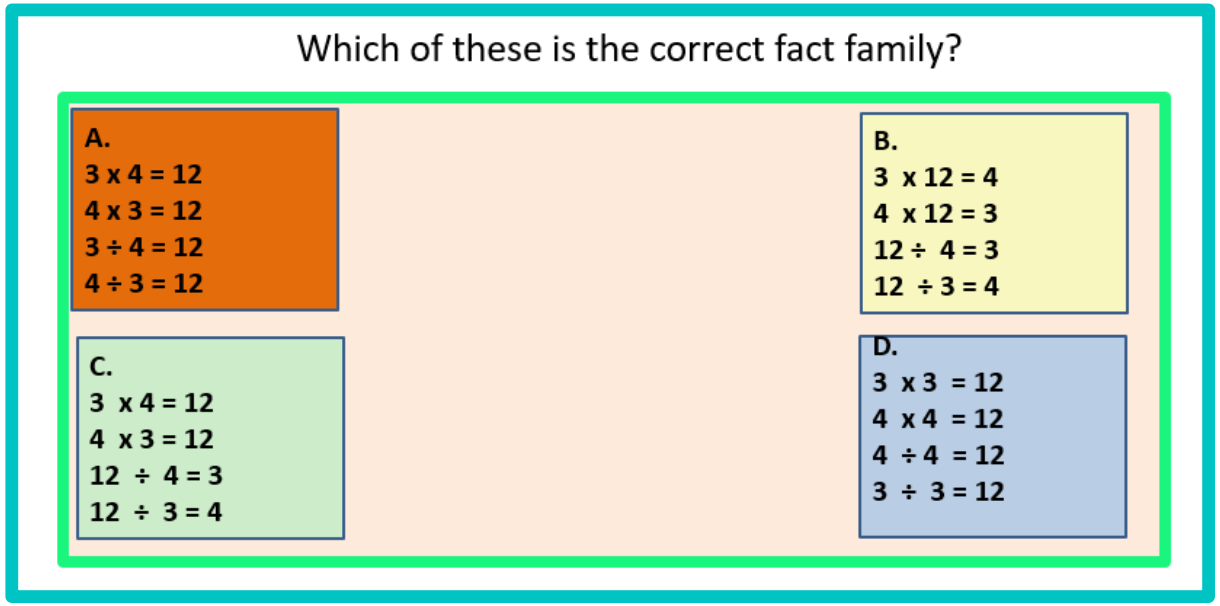
A question is usually asked midway in the lesson in order to allow time to address any misconceptions.

They should be answered within a short, limited period of time and are most often designed in the form of multiple choice.

To show their thinking, learners might use:

- 'show me' boards
- polls such as 'online forms quiz'.

Options offered to learners should be carefully created and should guide us to identify where potential misconceptions may have arisen.



Suitable for all levels.

Further examples can be found here: -
Maths Diagnostic (Hinge) Question of the Week (mrbartonmaths.com)

Assessment opportunities:

- Which learners need further input?
- Are there any misconceptions that need addressed?
- How does this impact on next steps in learning?

Always/Sometimes/Never

The Approach

- Learners are provided with mathematical statements and have to use reasoning to decide whether the statement is always, sometimes or never true.
- Learners should be asked to justify their thinking and provide several examples to prove that their decision is the right one.

Early Level	First Level
• A shape with four sides is a square. • I can share eight apples equally among my brother, sister and myself. • 12 – 6 is the same as 6 – 12. • I can only use one coin to make 10p.	• The sum of three numbers is odd. • Multiples of 5 end in a 5. • Numbers with more digits are greater in value. • The sum of four consecutive numbers is divisible by 4.
Second Level	**Third/Fourth Level**
• A square number has an even number of factors. • When you cut a piece off a shape you reduce the area and perimeter. • Numbers with more decimal places are larger.	• A prime number is odd. • If you subtract a positive number, the answer will be smaller. • $x^2 + y^2 = (x + y)^2$

Examples of what they might look like.

Assessment opportunities:

- Can the learners use different examples to test their theory?
- Can learners explain their thinking?
- Where do any misconceptions appear?

Plenary Questions

Where might you use what you have learned?

What do you need more support with? How can you help yourself?

What do you know now? What are you able to do now?

Plenaries can help to identify what the learners have learned and can help plan the next steps.

They can be used for reflection, to summarise and to reinforce.

They should be planned carefully into the lesson with enough time set aside.

They are often used at the end of a lesson, however, they can be used throughout a lesson.

A range of formative assessment approaches could be used for these type of questions e.g. 'show me' boards, exit passes, quizzes, etc.

Can you prove it?/ Can you convince me?

What would you like to learn more about? How can you do this?

What skills have you developed?

Collaborative Tasks

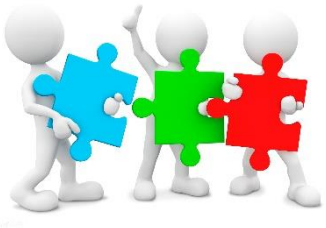
Discussion points/reflective questions

- In what way do we currently embed questioning as an assessment approach into our planning?
- Which of these approaches do we use more of/less of? Why might this be the case?
- In what ways can we build some of these ideas into our planning of N&M lessons?
- What are they benefits of using these approaches (a) for learners? (b) us as practitioners?
- How can we ensure that questions are utilised effectively throughout lessons?
- How can we ensure that all learners benefit from the questions we ask?

Task

Think about your next few lessons in N&M. Can you embed some of these questioning examples into your planning?

- Try to incorporate a questioning approach that you have not used before.
- Consider when you will use these questions within your lesson.
- Consider the assessment opportunities that your planned questioning approaches will provide.



Further Professional Learning - Questioning

Higher order thinking skills in maths | Learning resources | National Improvement Hub (education.gov.scot)

Using Questioning to Stimulate Mathematical Thinking (maths.org)

Effective Questioning In The Classroom: 9 Teacher Tested Techniques (thirdspacelearning.com)

The Art of Effective Questioning : Maths — No Problem! (mathsnoproblem.com)

Asking Questions and Promoting Discourse - National Council of Teachers of Mathematics (nctm.org)

https://mathequalslove.net/category/practice-structures/always-sometimes-never/

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