Using units of measurement: Years 3–4

MATHEMATICS CONCEPTUAL NARRATIVE

Leading Learning: Making the Australian Curriculum work for us
by bringing CONTENT and PROFICIENCIES together

www.acleadersresource.sa.edu.au

Government of South Australia
Department for Education and Child Development

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Resource key

This teacher will raise questions, answer students' questions and share some of her classroom practice.

This teacher will give you his top pedagogy tips.

These students will raise questions and model student thinking.

Bringing it to Life (BitL): key questions are in bold orange text.

Sub-questions from the BitL tool are in green medium italics – these questions are for teachers to use directly with students.

What the Australian Curriculum says about 'using units of measurement'

Content descriptions

Strand | Measurement and geometry

Sub-strand | Using units of measurement

Year 3 | ACMMG061
Students measure, order and compare objects using familiar metric units of length, mass and capacity.

Year 4 | ACMMG084
Students use scaled instruments to measure and compare lengths, masses, capacities and temperatures.

Year 4 | ACMMG087
Students compare the areas of regular and irregular shapes by informal means.

Year 4 | ACMMG290
Students compare objects using familiar metric units of area and volume.

Year level descriptions

Year 3 | Students use familiar metric units to order and compare objects.

Year 4 | Students use instruments to measure accurately.

Year 4 | Students formulate, model and record authentic situations involving operations.

Achievement standards

Year 3 | Students use metric units for length, mass and capacity.

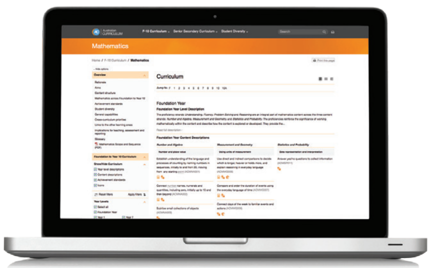
Year 4 | Students compare areas of regular and irregular shapes using informal units.

Year 4 | Students use scaled instruments to measure temperatures, lengths, shapes and objects.

Numeracy continuum

End of Year 4 | Estimate and measure with metric units
Students estimate, measure and compare the length, temperature, volume, capacity and mass of everyday objects using metric units and scaled instruments.

In the Australian Curriculum: Mathematics, the concept of 'time' is addressed in the sub-strand 'Using units of measurement', but in this resource, 'time' has its own narrative.



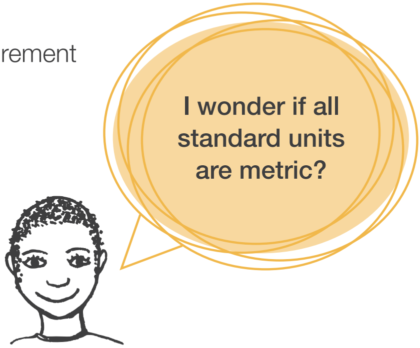
Source: ACARA, Australian Curriculum: Mathematics, Version 8.1

Working with units of measurement

Important things to notice

When we design learning about measurement, it is easy to think solely about ‘using measuring instruments’ (either informal or metric). It is also important to design opportunities for students to:

- **select** appropriate units
- **identify** measurable attributes
- **develop language** associated with measurement
- **estimate** using metric units.



Building on learning from past years

A quick look at Foundation to Year 2

During Foundation to Year 2, students measure, order and compare using informal units.

There are many techniques that can be used when measuring and comparing using informal units. Details about these techniques are elaborated in the Foundation to Year 2 ‘Using units of measurement’ narrative. An outline of the progression of techniques is:

1. **Direct comparison.**
2. **Indirect comparison, using a single informal unit.**
3. **Indirect comparison, using multiple informal units.**
4. **Indirect comparison using, informal units iteratively – Measuring using one unit length repeatedly.**
5. **Calibrating and using measuring devices.**

We would expect most students entering Year 3 to understand that objects have different measurable attributes. For example, students would understand that, for a tea-cup, they could measure how much the cup holds, how much it weighs and that different measurements of length can be made (height, width etc).

Students should be able to:

- suggest suitable informal units for making measurements
- understand the need for informal units to be uniform in size.

Developing an ability to estimate

Different ways to reason when estimating length

Is estimating guessing?

No. Estimating is reasoning, not guessing. We can estimate in lots of different ways.

Typically we estimate distance in one of the following ways:

A comparison to another known distance:

I know my classroom is about 5m wide and this room is about the same as my classroom.

Pacing or marking out:

I know my paces are about half a metre, so 10 paces is 5 metres.

A comparison to another length and then an adjustment:

I am about 150 cm tall and this cupboard is a bit taller than me, so it's about...

Visualise/mark out the unit distance and count:

I can think about how long a 'one metre' ruler is and visualise laying 'one metre' rulers end to end across the room. Sometimes, I visualise the rulers to the half way point and double that measurement.

Engaging learners

Harnessing students’ fascination with scale

People are often fascinated with very large or very small items. We are particularly fascinated with large items that should be small and small items that should be large. For an example of this fascination, follow the link below to the news story about giant marionettes in Perth, WA. An estimated 1.4 million people attended *‘The Giants extravaganza’*!

http://www.perthnow.com.au/news/western-australia/giants-in-perth-day-three/story-fnhocxo3-1227220081679

Perth Now
February 2015
Picture: Stewart Allen

To use this story to engage learners we would play one of the news stories, without the audio (at first) and ask students:

What questions do you have?

There are films, such as *‘The Borrowers’* and *‘Gulliver’s Travels’*, that play on our fascination with scale. Such films and images can be used to make connections between measurement, scale, enlargement and fractions.

Images of large amounts of money and movie scenes that involve the transaction of large amounts of cash in small bags, or briefcases, provide another engaging context for working with units of measurement.

We can support our students to develop a disposition towards using maths in their lives, ie becoming numerate, not only through the use of ‘real world’ maths problems, but through fostering a disposition towards asking mathematical questions about everything they see. We develop this disposition in our students when we promote, value and share their curiosity and provide opportunities for them to develop their questions and explore solutions to their questions.

! PAGES 8/9 ARE REALLY IMPORTANT – you will be tempted to skip them in your enthusiasm to get to the examples. You only need to READ THIS ONCE EVER.

Embedding the Australian Curriculum: Mathematics proficiencies

Pedagogy supporting you to embed the proficiencies

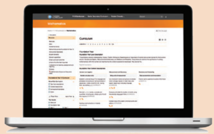
AC: Mathematics proficiencies

The verbs used in the four Mathematics proficiencies from the Australian Curriculum (AC: Proficiencies) describe the actions in which students can engage when learning and using mathematics content.

To embed the AC: Proficiencies in students learning experiences, we need to ask questions that activate those actions in students. But what questions will achieve this? The AC: Proficiencies describe the actions, but not the questions that can drive those actions.

There are four proficiency strands in the Australian Curriculum: Mathematics:

- Understanding
- Problem Solving
- Reasoning
- Fluency.



Bringing it to Life tool

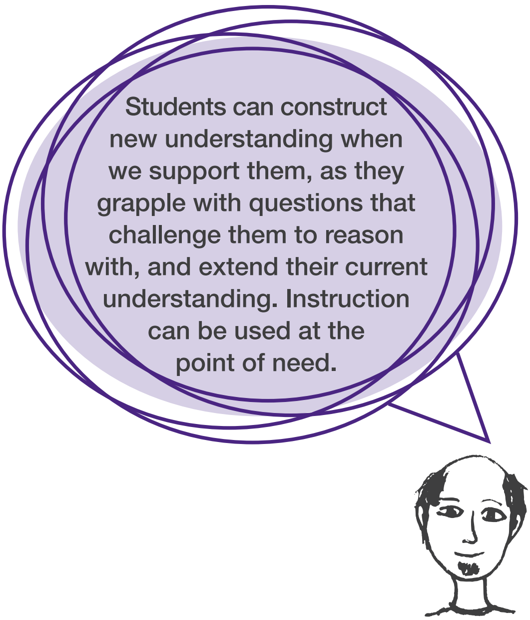
The Bringing it to Life (BitL) tool was developed by the South Australian Teaching for Effective Learning (TfEL) team, to support teachers to bring the AC: Proficiencies to life in the classroom. The BitL tool models questions that can be used to drive the actions described in the AC: Proficiencies.

The Bringing it to Life tool is located in the *Leading Learning: Making the Australian Curriculum Work for Us* resource (www.acleadersresource.sa.edu.au), in the section *Bringing it to Life – essence meets content*.

Beware of the old paradigm

There is a prevalent assumption that we should instruct our students with processes and develop their understanding before we challenge them to problem solve and reason. In this paradigm students will only gain problem solving experience at the end of the unit of work, assuming they get through all of the practice questions quickly enough.

The pedagogy shift of innovative educators across the world acknowledges that new understanding and the ensuing fluency are not simply a resource for problem solving and reasoning, but a product of problem solving and reasoning.



Why does this resource look at each proficiency separately, when they are intertwined skills?

We acknowledge that the proficiencies intertwine and that it is possible to experience a range of proficiencies within one particular problem. However, we have used the BitL questions to organise the examples into categories that emphasise each particular proficiency. The intention in doing this is to support teachers to understand the emphasis of each proficiency deeply in order to be able to intertwine them as appropriate.

You will find less of an emphasis, in this resource on fluency examples, as many textbook and worksheet resources already provide this.

Examples modelling embedding the proficiencies using BitL questions:

- **Understanding**
  Examples 1–10
- **Problem Solving**
  Examples 11–17
- **Reasoning**
  Examples 18–24
- **Fluency**
  Examples 25–31

It is intended that teachers will select/adapt and sequence examples that are appropriate for their students. These examples have been grouped by proficiency, not learning sequence.

Proficiency: Understanding

Proficiency emphasis and what questions to ask to activate it in your students (Examples 1–10)

The AC: Mathematics defines the proficiency of 'Understanding' as:

What the AC says

Proficiency: Understanding

Students build a robust knowledge of adaptable and transferable mathematical concepts. They make connections between related concepts and progressively apply the familiar to develop new ideas. They develop an understanding of the relationship between the 'why' and the 'how' of mathematics. Students build understanding when they connect related ideas, when they represent concepts in different ways, when they identify commonalities and differences between aspects of content, when they describe their thinking mathematically and when they interpret mathematical information.

BitL tool

There are three BitL questions associated with this proficiency. They reflect the student actions as described in the AC: Mathematics. The three questions are:

Q1 What patterns/connections/relationships can you see?

Q2 Can you answer backwards questions?

Q3 Can you represent or calculate in different ways?

Q1 Examples overview

What patterns/connections/relationships can you see?

The intent of this question is to promote learning design that intentionally plans for students to develop a disposition towards looking for patterns, connections and relationships.

Example 1: Comparing measurements
Identifying measurable attributes, and connecting to metric units

Example 2: What could we measure?
Identifying measurable attributes and connecting to metric units

Example 3: Scales, scales, scales!
Interrogating scales on instruments with familiar metric units

Example 4: Counting squares isn't always easy
Area

Q2 Examples overview

Can you answer backwards questions?

The intent of this question is to promote learning design that intentionally plans for students to develop flexibility in the way that they can work with a concept.

Example 5: How might this area have been worked out?
Area of irregular shapes

Example 6: What objects did I measure?
Connecting attributes to their metric units, estimating and measuring

Example 7: What's the object (estimation challenge)?
Estimating using metric units

Example 8: What might my rectangle look like?
Developing familiarity with metric units for area

Example 9: What might the block look like?
Developing familiarity with metric units for volume

Q3 Examples overview

Can you represent or calculate in different ways?

The intent of this question is to promote learning design through which students experience multiple representations and create multiple approaches. We encourage teachers to look for opportunities to:

- present information/problems in a range of ways
- ask the questions:
  Is there another possibility?
  Is there another way?

Examples 8 and Example 9 were written as 'backwards questions', ie students are given a measurement and asked to identify an object suited to that measurement. The questions in each of these examples can be extended by the teacher asking: *Is there another possibility?*

Example 10: Smallest to largest
Comparing objects using familiar metric units for area and volume

Example 1: Comparing measurements

Identifying measurable attributes, and connecting to familiar metric units

We can challenge students to look for attributes that connect different shapes, or objects, and ask students to identify suitable metric units. We can use this to reinforce the importance of identifying both what is being measured and what unit is being used.

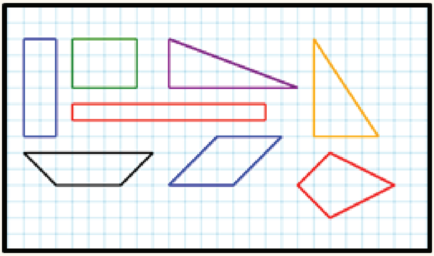


Figure 1

To do this, we can show students collections of shapes or objects that have at least one measurement in common and ask:

What measurement might be the same for all of these (shapes/objects)?

What would be different for them?

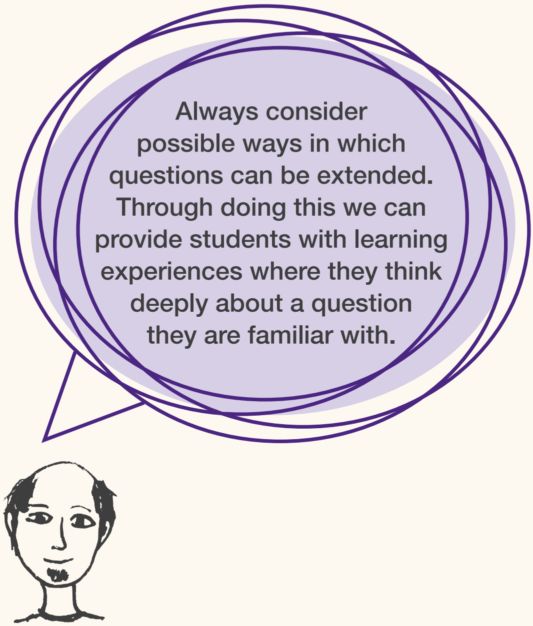
The group of objects could, for example, be the same length as each other but different mass. They could be cups that are the same height as each other, but have different capacities. They could be 2D shapes that are different in height/width, but have the same area as each other (as in Figure 1).

This question might become a problem solving activity for some students. We can support students to engage in questions such as this by first asking:

What measurements are definitely not the same?

We can support students to move closer to a solution, by asking:

What measurement might be the same? What are some possibilities? How could you check that out?



Suggested extensions

Extension 1: This activity can connect to learning about combining and splitting shapes

We could ask:

Without counting, convince me (or each other) that these shapes all have the same area.

This challenge supports students to understand that shapes of the same area cover the same amount of 2D space. Students can cut and rearrange each shape in Figure 1, to show that they have the same area.

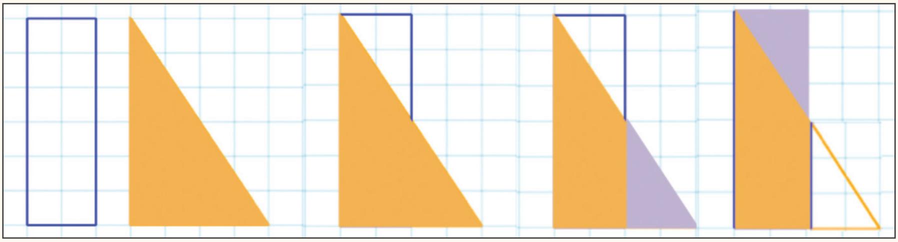


Figure 2

Figure 2 shows how the orange triangle can be cut and rearranged to clearly show that it covers the same area as the purple rectangle.

Once students have established that the shapes have an area of 12 squares, each one centimetre long and one centimetre wide (one square centimetre), we can also ask:

Is there another shape that would have an area of 12 centimetre squares?

Does a shape need to have straight sides to have an area of 12 centimetre squares?

What could it look like if the sides were not straight?

Extension 2: This activity can connect to learning about fractions

We could ask:

Which of these shapes has a measurement that is half (or a quarter) of the same measurement of another shape?

Example 2: What could we measure?

Identifying measurable attributes and connecting to familiar metric units

We can show a collection of objects/shapes (such as the collection in Figure 3) and ask:

What could we measure about all of these objects/shapes? What else? What else?

What units might you use to measure that?

Why wouldn't you choose (teacher suggest a unit that is too large or too small)?

In this collection we could measure the height, mass or capacity of each object. But, if we remove the bottle and replace it with a chocolate, we could ask:

What if we make this change, can we sill measure the same things for this collection? If not, why not?

Collections such as that shown in Figure 4, can also be used with the question:

Which object could we say is the odd one out? Why? Why else? (Find a reason that uses a measurement in the explanation. Prompt: The reason might be about the type of measurement that you can make, or about the size of the measurement.)

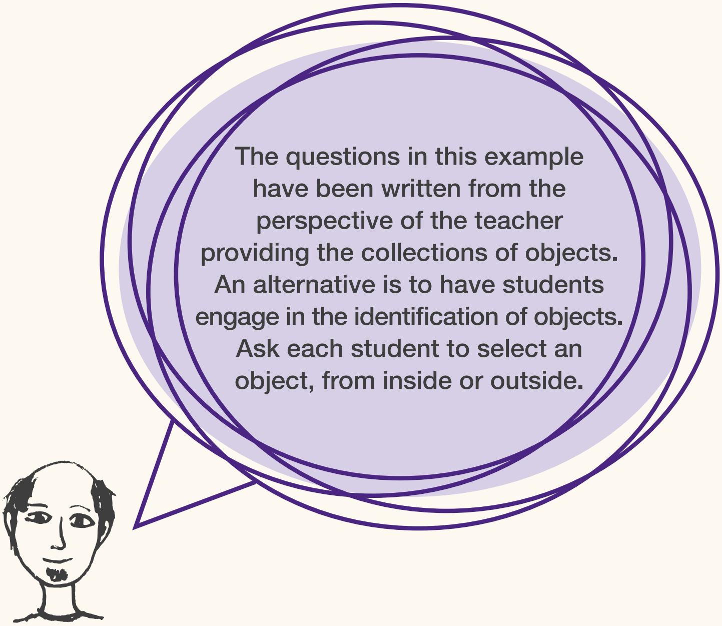
Could a different object be the odd one out for a different reason? Why? Why else? (Find a reason that uses a measurement in the explanation. Prompt: The reason might be about the type of measurement that you can make, or about the size of the measurement.)

Figure 3

Figure 4

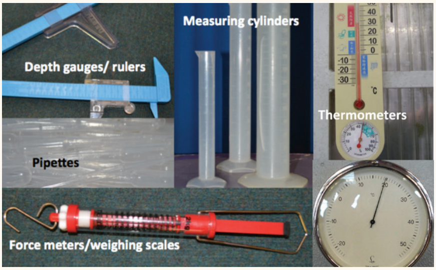
The focus of this task is to promote students' thinking about measurable attributes and approximating the value of that measurement. Students might identify that:

- they cannot measure how much the chocolate holds, but we can measure how much all of the other objects can hold
- the cup is quite heavy compared to the other objects.



Example 3: Scales, scales, scales!

Understanding scales on instruments with familiar metric units



Have students gather together various metric measuring tools (from home or school) that they are familiar with. Ask students what they notice about the scales on the tools. Then ask:

What's the same about all of the scales that we use?

What's different about all of the scales that we use?

We can use this type of question to challenge and support students to notice features of scales and to identify characteristics of scales, such as:

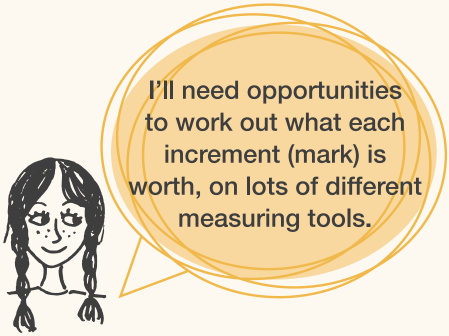
One mark doesn't always represent 1 unit. For example, 1 mark doesn't always represent 1 millilitre.

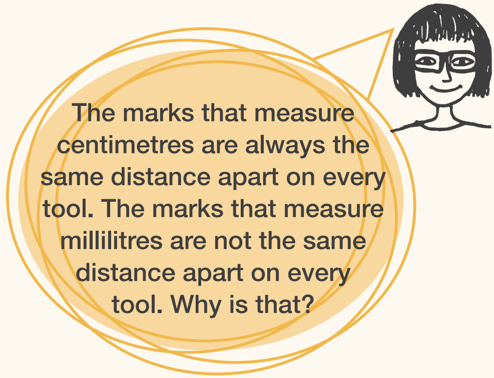
Some measuring tools have a label on every mark, but others do not.

When each increment isn't labelled, I need to stop and think to work it out for myself.

I could identify, collect and organise information about the different quantities that '1 mark' is worth on different measuring tools. Really noticing that one mark doesn't always represent one unit will help me to 'STOP AND THINK' about the value of increments.

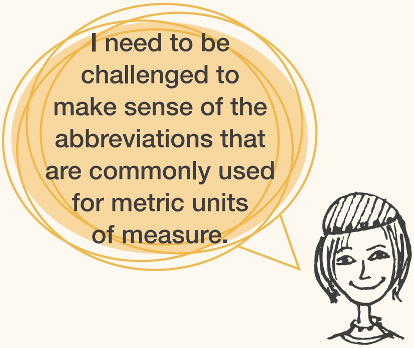
I'll be able to find out which increments are commonly used (1s, 2s, 5s, 10s, 20s, 25s, 50s and 100s). This will give me a starting point for identifying the value of the increments when I look at a new measuring tool.

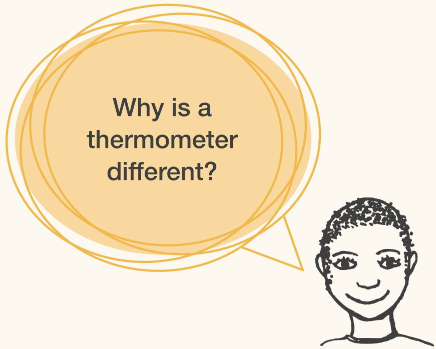




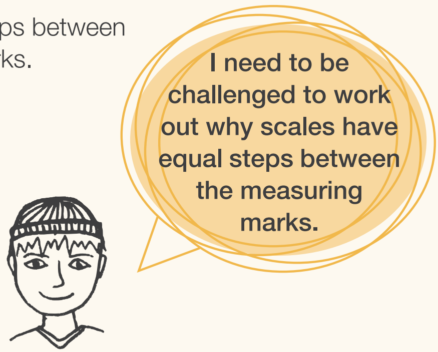
The symbol for the unit is displayed on the measuring tool, but the full of the name of the unit is not often displayed. For example, m/cm/kg/g/L/ml/°C.

Many scales start from zero. A thermometer is an example that doesn't.





Scales have equal steps between the measurement marks.



Example 4: Counting squares isn't always easy

Area

Centimetre-square overlays are often used when calculating area by counting squares. The position of the grid and the orientation of the shape can make it easier/harder to count the number of whole squares.

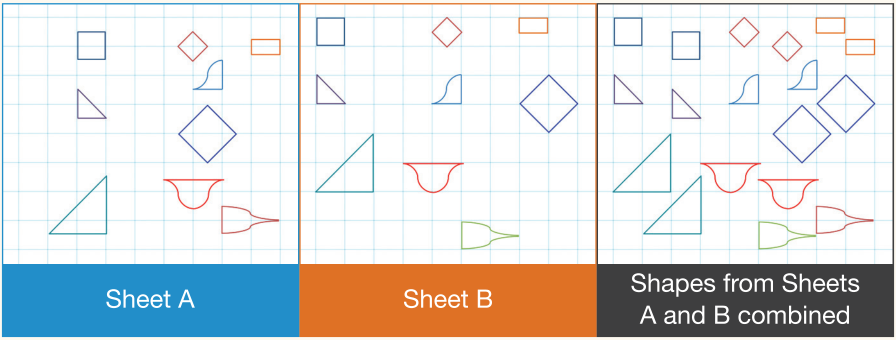


Figure 5

Images such as those shown in Figure 5, can be used to:

- support students to identify that changing the position of a grid can make it easier/harder to count squares
- challenge students to visualise splitting a shape and recombining the parts in order to 'see' one whole square centimetre.

The shapes on Sheets A and B are identical, but on Sheet B the shapes have been positioned to make the counting of whole and half squares much easier.

Ask students to have a go at working out the area of each of the shapes on Sheet A (harder sheet first). Let them grapple with this challenge, sharing their thinking with each other. Without resolving their difficulties, ask students to have a go at working out the area of the shapes on Sheet B. Then ask:

What connection did you see between Sheet A and B?

What was the same? What was different?

Which of A or B did you find easier? Which of A or B did you feel more confident about?

Why was that sheet (Sheet B) easier? What did you feel more confident about Sheet B?

Think about why you found one sheet easier than the other. If you were laying a grid over a shape, what would you try to do to make it as easy as possible for you to work out the area of the shape?

Share your idea with someone else. Try to convince each other that you have come up with a good idea.

Using resources such as this, we can challenge students to compare one shape to another. For example, compare different representations of one half of a square centimetre, such as shown here in Figure 6.

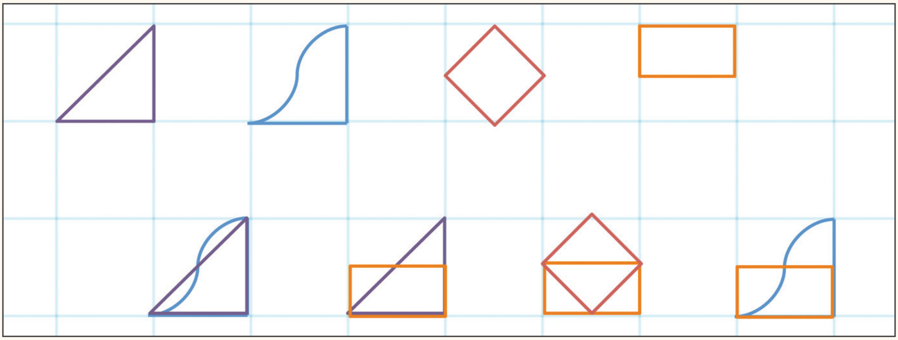


Figure 6

We can challenge students to explain, using diagrams or verbally, how the different representations of one half of a centimetre square can all be worth the same amount (Figure 7).

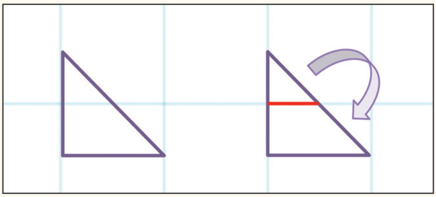


Figure 7

Example 5: How might this area have been worked out?

Area of irregular shapes

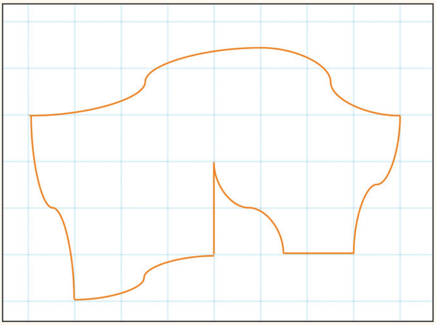


Figure 8

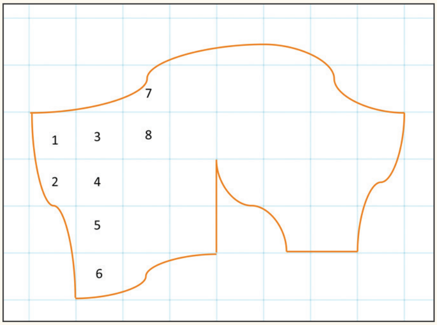


Figure 9

One way to find the (approximate) area of an irregular shape is to count the whole squares and then make whole squares up out of multiple parts of squares. A second method is to count (as one) any square where ½ or more of the square is inside of the shape and ignore sections where less than half of the square is inside of the shape.

We could say:

This shape has an area of approximately 27 to 28 centimetre squares.

How might I have worked that area out?

Prompt (Figure 9): Show an image where you have started to count (as one) any square where ½ or more of the square is inside the shape. Ask students:

What do you notice about the squares that I am counting in my shape?

We can challenge students to reason why a process works:

Why would this method work?

(Because the sections that are not counted compensate for the sections where a little too much is counted.)

Draw a shape for which this method wouldn't give you a good approximation of the area and explain why you think this.

A shape in which there is not a balance between the sections that are slightly under one half of a square and the sections that are slightly over one half of a square.

Example 6: What objects did I measure?

Connecting attributes to their metric units, estimating and measuring

Instead of giving students an object to measure, we can reverse the question, so that we give them the measurement and ask what the object might have been.

We could say:

I measured 5 objects.

These are the measurements that I recorded:
30 centimetres, 10 grams, 2 metres, 2 kilograms, 2 litres.

What might the 5 objects have been?

We can challenge students to select objects using their estimation skills and then measure to check how close their estimate was.

Students can then be challenged to improve on their first selection of objects and make a new selection of five objects that they think will be closer to the target amounts.

We can support students to focus on improving their estimation skills by valuing how many of the second set of objects were closer to the target measurement.

Example 7: What's the object?

Estimation challenge using metric units

To prepare for this activity, the teacher needs to take a few measurements for several objects found in the classroom and/or school yard. The teacher could measure the capacity, mass, length, width, height or perimeter of the objects, as appropriate. Students are then provided with a small selection of information about each object, such as the list shown below:

Object 1: What might the object be?

The object weighs (140) grams

Something about the object measures (8) cm

Something else about the object measures (6) cm

Something else about the object measures (4) cm

To introduce the activity, we could say:

I measured some objects and I'm going to give you some information about them.

Your challenge is to work out what the objects are.

BUT:

You can't measure using instruments once the challenge begins!

You can have (10) minutes to measure (and record) some lengths about yourself (For example, hand, foot, arm span). Think carefully about these measurements because you don't know (yet) if you are going to be working with small, or large measurements.

You are also allowed to weigh two objects and keep them with you for the challenge.

You are also allowed to measure the capacity of one container and keep that with you during the challenge.

Once our measuring time is over, all measuring tools need to be put away.

DEVELOPING A COMMUNITY OF LEARNERS

This activity works well with pairs or small groups, as the time given for the recording of measurements is limited and is best managed if students take responsibility for gathering different measurements.

This activity can also be used to support students to think about grouping themselves fairly and respecting diversity. For example, students might consider it fair/useful to have:

- a tall person and a small person in each group
- a person who does a lot of cooking (and is familiar with working in grams) in each group
- a person who is good at organising people and information in each group etc.

Example 8: What might my rectangle look like?

Developing familiarity with metric units for area

It is not until Year 5 that we would expect students to establish efficient ways of calculating area. This activity is not intended to achieve that, but it is intended to:

- build familiarity with using square centimetres as a standard unit for measuring area
- develop understanding that the same area can be represented in many different ways.

Give students the following information:

I'm thinking of a rectangle.

The area of my rectangle is 24 centimetre squares.

Then ask:

What might my rectangle look like?

Are there other possibilities?

How many possibilities do you think you might find?

Suggested extensions

Extension 1: This activity can be utilised to develop multiplication understanding

If students have responded to the initial question by thinking about splitting the centimetre squares into fractions (for example, creating a rectangle that is 1½ cm by 16 cm) then for this extension question you will need to ask them to think just about the whole-number possibilities. Ask students:

Will there be as many possibilities for all values?

For example, if we had 30 centimetre squares, instead of 24 centimetre squares, do you think there will be more/less/the same number of possible rectangles? Why?

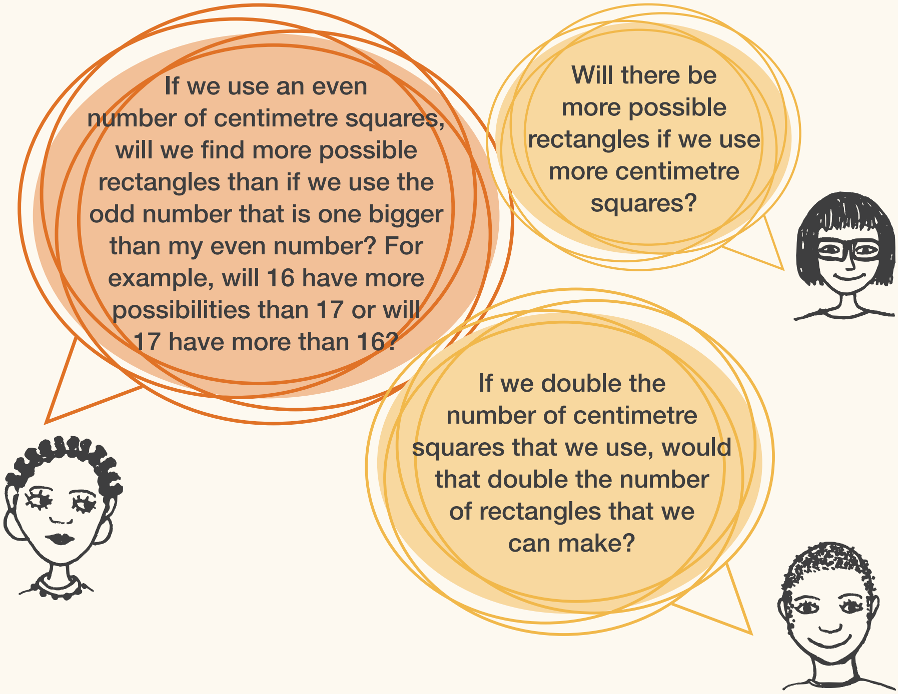
Can we find any connections between the number of square centimetres that we use to make our rectangles and the amount of rectangles that we can make?

What do you notice about the areas that have the most possibilities/the least possibilities?

In this activity there are many questions to which we can add:
Is there another possibility? Is there another way?

In Example 8, students are essentially creating different arrays, so we can make use of this activity to support the development of students' understanding of multiplication.

Teachers and students can brainstorm patterns and connections they are wondering about, but here are a few wonderings to get you started:



Extension 2: This activity can be utilised to include counting by unit fractions in a context

When working on the original question (a 24 centimetre square rectangle), some students may have begun to experiment with half squares. If so, ask them to share their idea with the class. If not then ask:

If we could cut the centimetre squares in half, would it be possible to make even more different rectangles than when we used whole centimetre squares?

For example, what if your rectangle was half a centimetre wide, could you make a rectangle that has an area of 24 centimetre squares? (This could be extended to quarters, thirds etc)

Example 9: What might the block look like?

Developing familiarity with metric units for volume

This activity is not intended to introduce students to calculating volume, as this comes much later in their development, but it is intended to:

- build familiarity with using centimetre cubes as a standard unit for measuring volume
- develop understanding that the same volume can be represented in many different ways.

Ask students to:

Visualise a rectangular prism.

Identify examples of rectangular prisms.

Show a rectangular prism to get students started if necessary. Then ask:

If you used twenty four centimetre cube blocks to build a rectangular prism:

What might it look like?

Are there other possibilities?

How could you be sure that you've found all of the possibilities?

Convince me. Convince someone who thinks differently to you.

This problem could be extended in similar ways to Example 8.

Backwards questions are really just trickier application (choose and use, fluency) questions. They are questions that involve students choosing and using appropriate mathematics, but with a twist. An example of the twist may be that the student is given the solution and is required to work back to a possible starting point. It may be that there is a missing piece of information.

In this activity there are many questions to which we can add:

Is there another possibility? Is there another way?

Example 10: Smallest to largest

Comparing objects using familiar metric units for area and volume

This activity is not intended to introduce students to processes for calculating area and volume, as this comes much later in their development, but it is intended to:

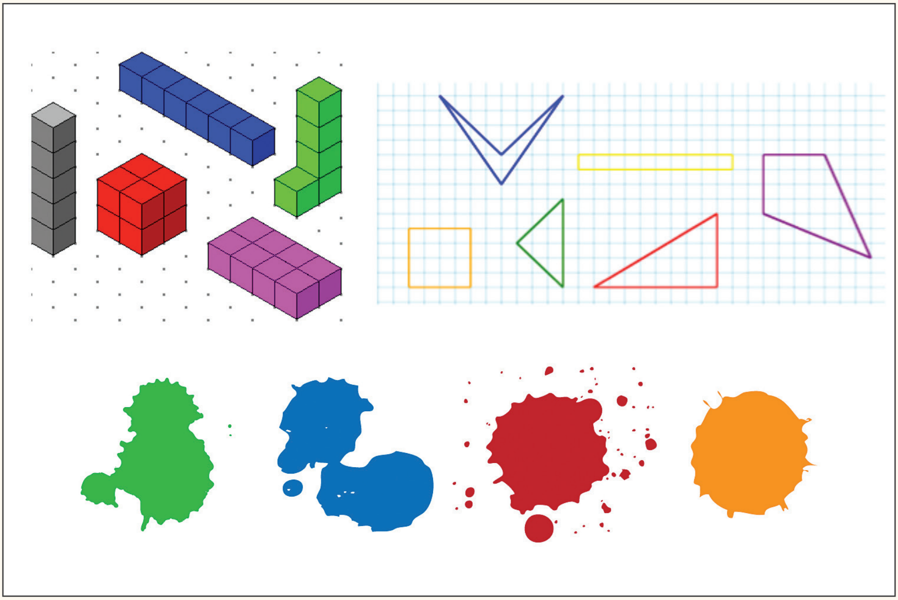
- build familiarity with using centimetre cubes as a standard unit for measuring volume and centimetre squares as a standard unit for measuring area
- develop understanding that the same volume/area can be represented in many different ways.

Students can order 2D shapes by height, width, area, or perimeter. Students could order 3D objects by length, width, depth, number of centimetre cubes used to build the object (volume) or the number of centimetre squares they can see on the surface of the object (surface area).

To introduce this activity, we can ask:

How might you order these shapes/ objects from smallest to largest? Is there another way? Is there yet another way? Etc

Convince someone who thinks differently to you.



Proficiency: Problem Solving

Proficiency emphasis and what questions to ask to activate it in your students (Examples 11–17)

The AC: Mathematics defines the proficiency of 'Problem Solving' as:

What the AC says	**Proficiency: Problem Solving** Students develop the ability to make choices, interpret, formulate, model and investigate problem situations, and communicate solutions effectively. Students formulate and solve problems when they use mathematics to represent unfamiliar or meaningful situations, when they design investigations and plan their approaches, when they apply their existing strategies to seek solutions, and when they verify that their answers are reasonable.
BitL tool	There are four BitL questions associated with this proficiency. The four questions are: **How can you interpret?** **In what ways can you model and plan?** **In what ways can you solve and check?** **Reflect?**
Examples overview	**Interpret; Model and plan; Solve and check; Reflect** The Problem Solving section of the BitL tool works differently to the rest of the maths BitL tool—the sequence of four questions reflect the problem solving process. Therefore, unlike the other three proficiencies, we have not provided examples categorised under each question. **Example 11: Using thermometers** Using metric units of measurement **Example 12: Missing objects** Estimating and connecting attributes to their metric units **Example 13: More Christmas boxes** Comparing volumes

Examples overview

Example 14: Oranges and lemons
Problem solving with mass

Example 15: Pies
Problem solving with mass

Example 16: A road and a pole
Problem solving with length

Example 17: How tall?
Problem solving with length

What's the difference between meaningful and unfamiliar problems?

Meaningful problems

Meaningful problems are those in which the mathematics and strategy being applied is familiar to the student. They have solved a problem similar to it before, so they can use the same strategy. The student understands the required content.

Unfamiliar problems

Unfamiliar problems include:

- Problems for which the students would not be able to say that they had done a similar example previously, they would therefore need to create an approach/develop a strategy
- Problems in which the students develop a new piece of knowledge. They begin the problem by applying the knowledge/skills that they have and they complete the problem having re-combined that knowledge to form a new piece of understanding.

BUILDING RESILIENCE

Unfamiliar problems tend to provoke a response of, 'I don't know' or 'I'm not sure'. Students respond differently to this feeling. Some students shut down, others begin to ask, 'But how could I work that out?'

In developing powerful learners we are aiming for all of our students to learn that 'not knowing' is the *beginning of a learning opportunity* and that the first move they need to make on the journey to *finding out more* is to ask, 'What could I do to work this out?'

Example 11: Using thermometers

Developing skills in using metric units of measurement

There are many scenarios that would facilitate practical work relating to the use of thermometers for measuring temperature.

We could ask:

If you measured out some water, ½ from the container of warm water and ½ from the container of cold water:

Could you predict the temperature of the mixture?

How could you test your ideas?

What information would you need to know?

The answer to this question is likely to be that it's really hard to predict the temperature of the water. That's fine. The purpose of the activity is for students to problem solve, reason and to measure using millilitres and degrees Celsius.

Asking a simple question such as this, or using a stimulus such as Figure 10, creates an opportunity for students to ask, 'How do we measure temperature? What units do we use? What do we mean by 'cold/warm' water? Does cold water come from the fridge or the cold tap? Is all water from cold taps the same temperature? What temperature is warm compared to hot? What is a safe temperature for us to work with? How could we find that out (safely)?'

The temperature of cold water from taps around the world varies widely and there is some data to be found through Internet searches about this topic. In South Australia there will be differences between houses with mains water, rain water and bore water. There will also be differences across the year, particularly for those households using rainwater. This provides an opportunity for students to collect and share data.

Figure 10

> Where I live, the cold tapwater is always too cold;
> so cold that it stings my fingers almost-instantly, and it's useful for stopping nosebleeds.
> Put into degrees, our tapwater ranges from 7-12 C most of the year.

Figure 11 http://www.ask.com/food/average-temperature-cold-tap-water-2bd0ae80e91f5646

Temperature, time and volume

Students may be interested to conduct some experiments about water heating up or cooling down over time, under different conditions.

Such experiments bring together the measurement of temperature (°C), time (seconds/minutes/hours, depending on the conditions of the experiment) and volume (ml or L).

Example 12: Missing objects

Estimating and connecting attributes to their metric units

We could say about Figure 12:

I have lined up these objects from lightest to heaviest. I have left two empty places in the line-up.

Your challenge is to identify one object for each of the empty spaces, keeping in mind:

- *You **can't** touch or measure any of the objects in the line-up until you have made your selections*
- *You **can** weigh any objects that have not been used in the line-up.*

We can support students to think and reason using their understanding of mass, rather than just guessing. To do this we can ensure that they have access to:

- a variety of objects that would be similar in mass to the objects that are in the line-up
- a variety of measuring scales (electronic scales, analogue scales, balance scales and weights).

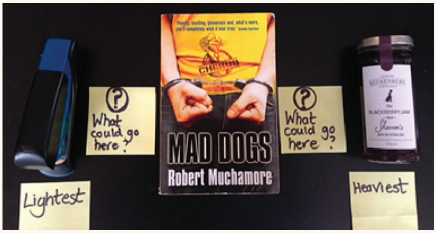


Figure 12

We can challenge students to make a convincing case for the object they want to put in a particular position, using metric units in their argument. For example, students might weigh a few books that are similar in appearance to the book in the problem. They might weigh a different stapler or something that they think might be of a similar mass. Students could use their research to establish a possible range for the mass of the missing objects.

We should give students every opportunity to design a process such as this for themselves, before we begin to provide structure for them.

Interpret

What have you been asked to find? What information might help you to make decisions? Remember that telling students or prompting them heavily at the start of a task is STEALING the opportunity for them to feel a sense of achievement that is gained from grappling with a problem.

Model and plan

Do you have an idea? How might you start? What equipment will be helpful? If you can't weigh the objects in the line-up, what could you weigh instead? How are you going to convince someone that your objects will fit in the pattern of the line up? How are you going to record the information that you find out? Speak to someone who you think is being a good problem solver today and ask them to show you what they are trying.

Solve and check

How many grams do you think this (book) will weigh? Show me how you are using these (electronic) scales to help you? Why did you choose to weigh this object, is it similar to one in the line-up?

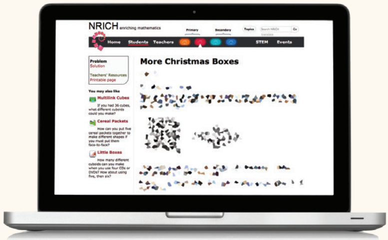
Reflect

Did other people solve this problem in a different way? Is there something that you would do differently next time? Try to remember the mass of one of the objects, so that you can compare other objects to it in future estimation problems.

Example 13: More Christmas boxes

Comparing volumes

This problem challenges students to compare different volumes, using centimetre cubes. It would be possible to extend the task to include generating a formula for calculating volume, but this is not the focus of the task and hence it is appropriate for Year 4 students.



The link to this problem on the NRICH site is: http://nrich.maths.org/975

Example 14: Oranges and lemons

Problem solving with mass

The context of this problem is mass, but it's a great application of addition, subtraction and/or multiplication and division. It challenges students to use a trial and improvement strategy and think about keeping information in an organised form. Note: The picture does not show the solution to the number of oranges and lemons.

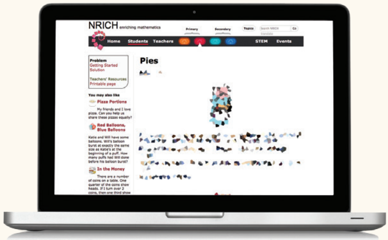
The link to this problem on the NRICH site is http://nrich.maths.org/1063

Example 15: Pies

Problem solving with mass

The context of this problem is mass, but it's a great application of simple fractions, and multiplication and division.

The link to this problem on the NRICH site is http://nrich.maths.org/1031

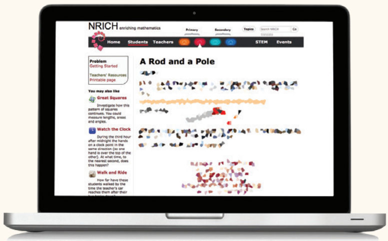


Example 16: A rod and a pole

Problem solving with length

The context of this problem is length, but it's a great application of addition and subtraction.

The link to this problem on the NRICH site is http://nrich.maths.org/994

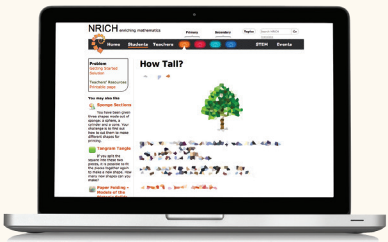


Example 17: How tall?

Problem solving with length

The context of this problem is length. It's a great practical activity that can be solved in many different ways, using a range of different levels of maths. Hint: One method could include the use of a photograph of your chosen tall object.

The link to this problem on the NRICH site is http://nrich.maths.org/7536



Proficiency: Reasoning

Proficiency emphasis and what questions to ask to activate it in your students (Examples 18–24)

The AC: Mathematics defines the proficiency of 'Reasoning' as:

What the AC says	**Proficiency: Reasoning** Students develop an increasingly sophisticated capacity for logical thought and actions, such as analysing, proving, evaluating, explaining, inferring, justifying and generalising. Students are reasoning mathematically when they explain their thinking, when they deduce and justify strategies used and conclusions reached, when they adapt the known to the unknown, when they transfer learning from one context to another, when they prove that something is true or false and when they compare and contrast related ideas and explain their choices.
BitL tool	There are four BitL questions associated with this proficiency. They reflect the student actions as described in the AC: Mathematics. The four questions are: **Q1 In what ways can you prove?** **Q2 In what ways can you communicate?** **Q3 In what ways can we generalise?** **Q4 What can you infer?**
Q1 Examples overview	**In what ways can you prove?** The intent of this question is to promote learning design in which students justify their (mathematical) actions in order to develop an increasingly sophisticated capacity for logical thought and action. We can look for opportunities to ask students to prove their thinking to you, to themselves, or to their peers. Whether an answer is right or wrong, we can be ready to say: *Are you sure? Convince me, convince someone who thinks differently to you.* *Convince me*, often builds on from a sequence of thinking. **Examples 1**, **4**, **9** and **10** all ask students to convince someone about their ideas.

Q2 Examples overview

In what ways can you communicate?

The intent of this question is to promote learning design that intentionally plans for students to compare, contrast and evaluate different ideas and approaches and to explain their reasoning using increasingly sophisticated mathematical terminology and conventions.

We must intentionally plan for communication to be in different modes, including written, verbal, symbolic and descriptive.

Example 18: The barrier challenge
Why do we need standard units?

Example 19: The broken ruler
Reasoning using metric units of measurement

Example 20: True or not?
Reasoning using metric units of measurement

Q3 Examples overview

In what ways can we generalise?

The intent of this question is to promote learning design that intentionally plans for students to look for generalisations. As students learn to generalise, they see mathematics as a set of connected ideas, rather than lots of separate rules and processes.

Example 21: Rules for effective measuring
Effective use of metric measuring instruments

Q4 Examples overview

What can you infer?

The intent of this question is to promote learning design in which students think about the implications of information they have and develop flexibility to refine their thinking as more information is used.

Example 22: Sorts™ (Game by Crown & Andrews)
Ordering, without all of the information

Example 23: Estimating mass
Estimating using metric units of measurement

Example 24: What's my weight?
Estimating measures of mass

Example 18: The barrier challenge

Why do we need standard units?

This activity is based on the idea that challenging students to communicate with precision, but without standard units, can help them to understand why standard units were established.

Playing the game

If possible, a barrier such as a free-standing display board, or a curtain, is useful. If this is not feasible, then students can work back to back with each other.

Play in pairs (back to back) or fours (one pair back to back with another pair).

The challenge

The person on one side of a barrier needs to communicate a length to the person on the other side of the barrier, without the use of standard units or the same informal units. For example, Judith (on side A of the barrier) has a piece of string and she needs to get Pamela (on side B of the barrier) to cut a piece of string that is exactly the same length as hers.

Judith could try describing the length using her feet, or hands or finger/thumb widths, or arm span, or stride, or a combination of those informal units.

We can:

- **Challenge students to communicate short and long lengths and reflect on the accuracy of communication that they achieve.**
- **Use different materials. For example, string, cardboard, elastic, masking tape, plasticine.**
- **Challenge students to communicate the size and shape of a 2D shape area rather than just one length.**
- **Harder: Challenge students to communicate a mass. For example, give one person pebbles, or plasticine, and challenge their partner to use a different resource to construct the same mass.**

Repeat the game using metric measuring tools

Play the barrier challenge game again, but with access to metric measuring tools. Then compare:

- the ease of communication when using metric measures versus informal measures
- the accuracy of reproduction of the length or mass.

When students engage in this thinking, often, they will identify that having the same unit as each other is really important in enabling them to communicate the measurement with accuracy.

Occasionally groups of students will observe that after several attempts using the same informal measure with one partner, they become increasingly accurate in their use of each other's informal units. For example, Pamela learns that Judith's hand is just a little smaller than hers, so Pamela learns to make good estimates of length based on knowing this.

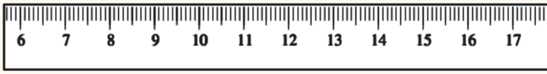
When students notice that the key to successful replication of measurements is having a shared understanding of that measurement, we can draw their attention to the fact that standard metric units are just a world wide version of this.

We can also engage students in identifying situations in which they still see informal units being used in their life and why that happens. We can challenge them to identify situations in which metric measurements are necessary/preferable and situations in which informal units are a suitable choice, or even preferable, to metric units.

Example 19: The broken ruler

Reasoning using metric units of measurement

You have a pencil that is 10 cm long:



How could you convince someone that it is 10 cm using this broken ruler?

Where could the pencil start, where could it end?

Is there another possibility?

Example 20: True or not?

Reasoning using metric units of measurement

Asking, *Why can't it be...?* is one way to hear students' reasoning.

We can set up scenarios that draw attention to common measuring errors. For example, don't set the scale to zero before placing an object on the scale. The scales in Figure 13 show a highlighter pen that apparently weighs about 500g (or ½ kg).

We can ask:

What's the mass of this highlighter pen? Could this be real? Why can't it be real?

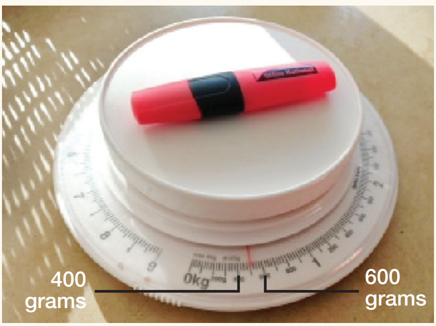


Figure 13

Why can't this statement be true about Figure 14? This pen is just over 13 centimetres long.

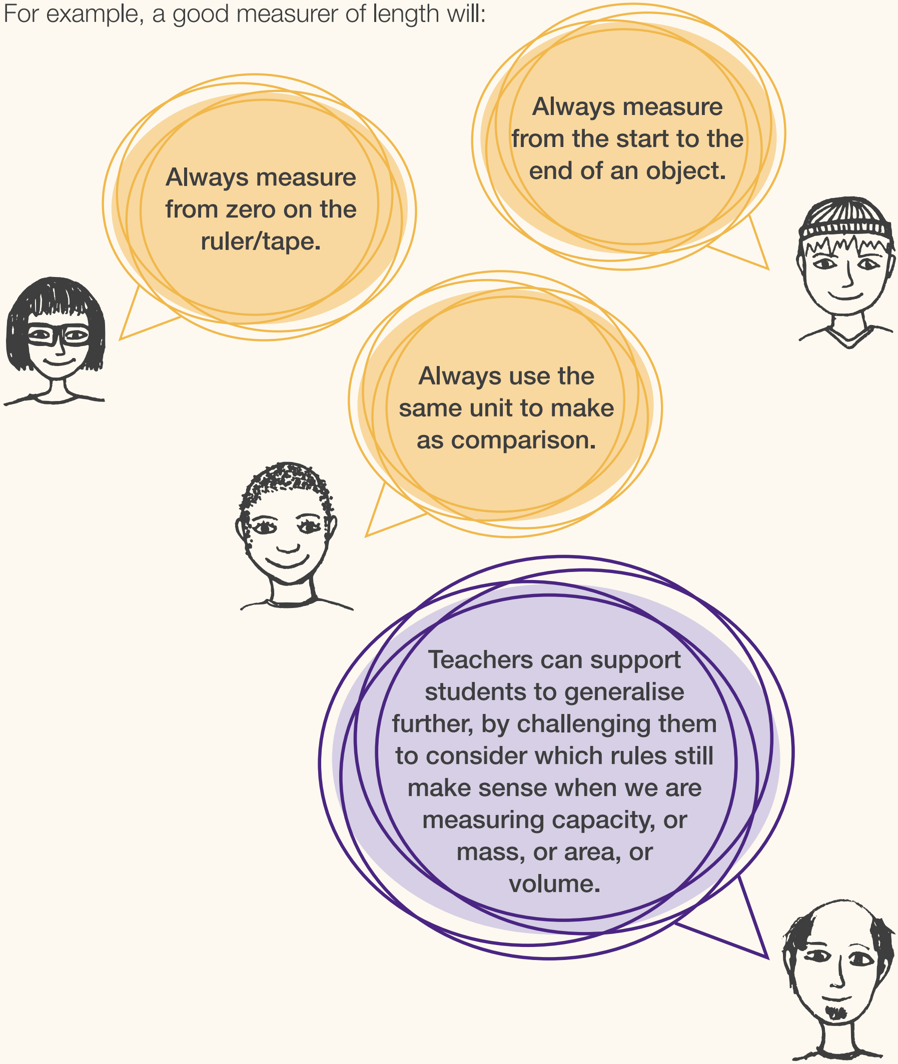
Figure 14

Example 21: Rules for effective measuring

Effective use of metric measuring instruments

We can challenge students to articulate rules that ‘an effective user of metric measuring instruments’ would follow.

For example, a good measurer of length will:



Example 22: Sorts™ (Game by Crown & Andrews)

Ordering, without all the information

The focus of this game is about putting things in order. The challenge lies in the fact that students are required to order items, without having all of the necessary information.

For example, the cards shown in Figure 15 asks students to order (from tallest to shortest):

- Monster trucks
- Uluru
- Empire State Building
- Mount Everest.

To be able to suggest an order for these objects, students would need to make inferences based on information they do have.

The solution provided with each card could be used to engage students in reading and understanding metric measurements.

We could capitalise on students' interest in some of the solutions, by asking students to model the relative sizes of some of these objects. For example, use the school oval to show the height of the Monster truck, Uluru and the Empire State Building. A local map could then be used to identify the location of the top of Mount Everest relative to a starting point on the oval.

Figure 15

Example 23: Estimating mass

Estimating using metric units of measure

Put two collections of objects together. Allow students to weigh the individual objects in one of the collections and challenge them to use that information to help them to estimate the mass of the individual objects in the second collection. For example:

- **Collection A:** an apple, a pen, a ball of wool, a cup, a teddy bear, a box of staples, a flower.
- **Collection B:** an orange, a pencil, a water bottle, a toy car, a tennis ball.

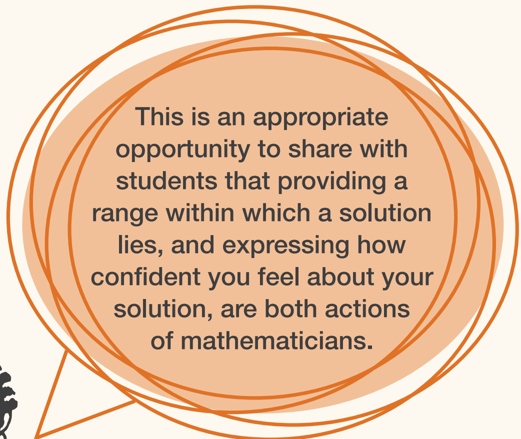
We could say:

Use any of the objects in Collection B to help you to estimate the mass of the objects in Collection A.

Convince me that you have really used Collection B to support your estimating of Collection A.

Students can be challenged to:

- Commit to a particular estimate (eg 240 grams) and also to provide a range within which they think the answer lies (eg 200 to 300 grams).
- Comment on how confident they feel about the two different estimates. They are more likely to feel confident about giving a range of possibilities, rather than just one estimate. The larger the range they use, the more confident they will feel. This is worthy of discussion with students.
- Identify if they feel more confident about their estimate for any particular object. They may feel more confident about their estimate if they have measured something very similar.



Example 24: What’s my weight?

Estimating measures of mass

The context of this problem is mass, but it’s a great application of addition, subtraction and/or multiplication and division. This problem really challenges students to appreciate that sometimes we don’t have enough information to be sure about one answer, but we can make suggestions about a possible range of answers.

The link to this problem on the NRICH site is http://nrich.maths.org/210

Notes

Proficiency: Fluency

Proficiency emphasis and what questions to ask to activate it in your students (Examples 25–31)

The AC: Mathematics defines the proficiency of ‘Fluency’ as:

What the AC says	**Proficiency: Fluency** Students develop skills in choosing appropriate procedures, carrying out procedures flexibly, accurately, efficiently and appropriately, and recalling factual knowledge and concepts readily. Students are fluent when they calculate answers efficiently, when they recognise robust ways of answering questions, when they choose appropriate methods and approximations, when they recall definitions and regularly use facts, and when they can manipulate expressions and equations to find solutions.
BitL tool	There are two BitL questions associated with this proficiency. They reflect the student actions as described in the AC: Mathematics. The two questions are: **Q1 What can you recall?** **Q2 Can you choose and use flexibly?**
Q1 Overview	**What can you recall?** The intent of this question is to promote learning design in which students develop their capacity to recall mathematical information and processes. Many worksheets are fluency driven exercises. Practice is a necessary part of developing fluency, but we should be purposeful about addressing the other proficiencies and be purposeful about developing fluency. There are many worksheets that require recall of measurement related information. Instead of examples, in this section we have provided guidance about the language, facts and connections that we can aim for students to have recall of by the end of Year 4.

Q2 Examples overview

Can you choose and use flexibly?

The intent of this question is to promote learning design that intentionally plans for students to experience contexts in which they can choose to use knowledge and skills that they have developed.

Example 25: Preparing for success with scaled instruments

Example 26: Personalising units of area before introducing standard units

Using squared units for area

Example 27: Bridge building challenge

Working with length and mass

Example 28: Oh! Harry!

Using metric units of measurement

Example 29: Working with dinosaurs

Estimating and using metric units of measurement

Example 30: Olympic stars

Estimating and using metric units of measurement

Example 31: What's the volume of your robot?

Volume

What can you recall?

During Years 3–4 we can **challenge and support students to recall** that:

- length can be measured in millimetres, centimetres and metres
- capacity can be measured in millilitres and litres
- mass can be measured in grams and kilograms
- temperature can be measured in degrees Celsius.

During Years 3–4 we can **provide opportunities for students to notice and try to recall connections between units of measurement**, such as:

- 1 metre is equivalent to 100 centimetres
- 1 litre is equivalent to 1000 millilitres
- 1 kilogram is equivalent to 1000 grams.

It is not expected that students will convert between units of measurement at this stage, but for students to be able to work with metric measures, it is important for them to know the relationships between the familiar units that they are working with. Frequent opportunities to speak, hear, read and record this language and these facts will help students to commit this information to memory.

Practice is a necessary part of developing fluency. We should be purposeful about addressing all proficiencies.

I can't describe here what a fluency activity would look like, because an activity that requires problem solving for one Year 3 class, may be a fluency activity for a class that has already met that concept.

To decide if a particular worksheet or activity is a fluency driven exercise, ask yourself: **Do these questions require my students to do anything other than recall and choose and use known mathematical facts and processes?**

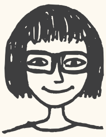
If the answer is no, then it's probably just fluency.

Estimation skills can be supported by recall

As estimation can be made by comparison to a known unit, it's useful for students to be able to recall a range of measurements that connect to their size, or to objects that are familiar to them. For example:

Estimating length

I remember that my little finger is about 1 cm wide. That helps me to estimate small lengths.



I want to find out how wide my hand is, so I can use it to help me to estimate length. I also think it would be good to know what it feels like to step out ½ a metre or a whole metre, then I could estimate larger distances.

When I am estimating length, I find it useful to know my own height and the height of the door.

Estimating mass

I let my students weigh and label items they use frequently. I think this helps their recall of the mass of a few familiar objects and they can use this knowledge when they are estimating. Also, when I'm cooking with students, I support them to notice measurements of mass, both as they weigh produce and as they read labels on pre-packed items such as butter.

Estimating capacity

Lots of my students can recall the capacity of soft drink containers, but I've noticed they don't automatically use that knowledge. Perhaps it's because they learnt it outside of mathematics lessons, that they are unaware of the value when solving mathematics problems.

Example 25: Preparing for success with scaled instruments

Calibrating (making) and using measuring tools with informal units has much value in relation to preparing students to use metric measuring tools.

When students work with metric measuring tools we see some common errors:

- measuring from 1 instead of zero
- counting the tick marks rather than the spaces.

And we see some inefficiency, when they:

- count spaces rather than trusting they can read the measurement from the scale.

When I see my students using tools in inefficient or incorrect ways, I support them to notice and correct their error rather than telling them the correct method straight away. I find that my students remember the correct approach over a longer period of time when they have been supported to notice why their original method is flawed or inefficient.

How do you use informal measuring tools to support students to correct these errors?

Well, let's say a student is using a measuring tool they calibrated in their 'hand widths'. If they measure from 1 'hand width' on their tool instead of correctly measuring from the zero tick mark, I prompt them to check their measurement using their actual hand width. The two answers will be different. Then I ask them which answer they feel most sure about. Usually they feel most sure about using their actual hand, so we start to explore what might have gone wrong when using the measuring tool.

Once students thoroughly understand the use of a measuring tool in the context of informal units of measurement, these skills can be transferred to working with metric units of measurement.

If I notice students making common errors when they are working with metric units of length, I find it useful to ask them to use centimetre cube blocks (MAB blocks) to check their measurement. But, if you try this, please make sure that the blocks are actually 1 cm x 1 cm x 1 cm, as some are a little smaller.

Example 26: Personalising units of area before introducing standard units

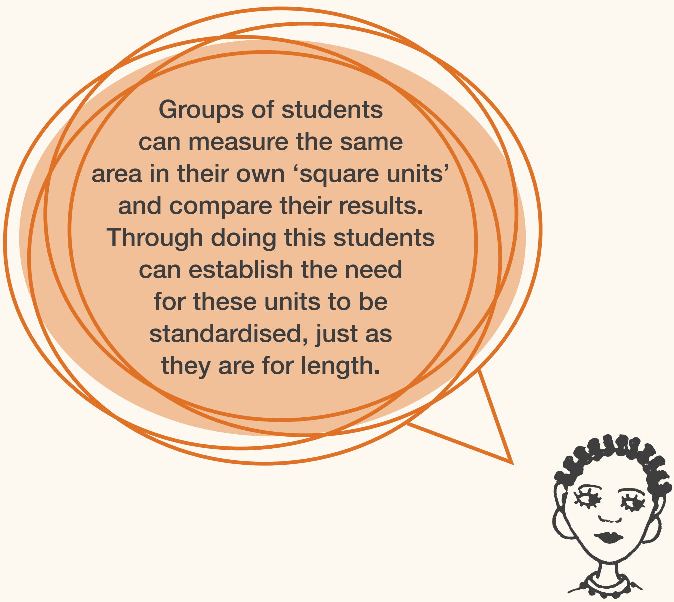
Using squared units for area

When we first introduce learners to measures of length, we do so using informal units of measurement. Often these units are 'personal' units of measure, such as hands, feet, cubits, fingers etc. Once the student has formed an appreciation of the need to measure from the beginning to the end of an object without leaving gaps, we extend the measurement of length to include the use of formal units of metric measure. Personal units of measure can also be used as a starting point for developing an understanding of 'square units' of area and 'cubed units' of volume.

Students can make (out of paper/card):

- **A square hand:** A square that is one hand long and one hand wide.
- **A square foot:** A square that is one of their feet long and one foot wide.
- **A square cubit:** A square that is one cubit long and one cubit wide.

Cubed units (for things like hands, feet, cubits etc) can be made from straws or other modelling materials.



Example 27: Bridge building challenge

Working with length and mass

Your challenge is to build a bridge that:

- *is more than (10) cm tall, but less than (20) cm tall*
- *has a gap that a (5) cm toy-car can drive under*
- *spans a (20) cm gap*
- *will support at least (1½) kg for at least 1 minute.*

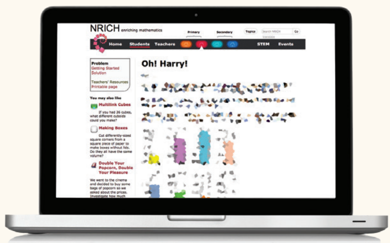
> My students negotiate the range of materials that are used, the amount of time that will be given and the size of the group working on each bridge.
>
> Sometimes I add other constraints, such as:
>
> - use at least 3 different materials, or
> - use only one material
> - use no more than (20) pop sticks etc.

Example 28: Oh! Harry!

Using metric units of measurement

The context of this problem is volume. It's a great application of practising reading scales in a challenging context.

The link to this problem on the NRICH site is http://nrich.maths.org/5979



Example 29: Working with dinosaurs

Estimating and using metric units of measurement

This article suggests ways in which dinosaurs can be a great context for discussing measurement.

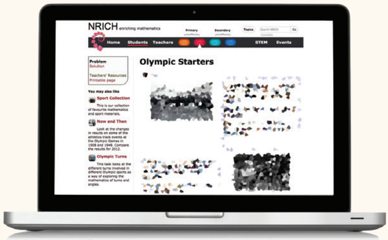
The link to this problem on the NRICH site is http://nrich.maths.org/5995

Example 30: Olympic starters

Estimating and using metric units of measurement

The context of this problem is measuring time and distances in standard units by looking at some historic Olympic results and whether students could do something similar.

The link to this problem on the NRICH site is http://nrich.maths.org/8170



Example 31: What's the volume of your robot?

Volume

Working with centimetre cube MAB blocks is a great opportunity to consolidate understanding of place value (partitioning/regrouping etc), while also developing an appreciation of volume.

Using 1 centimetre cubes, 10 cubic centimetres (lengths), 100 cubic centimetres (flats) and 1000 cubic centimetres (blocks), ask students to create their own model. Their model might be a robot, a face, an animal, a building etc.

Give students a short fixed amount of time for creating their model and then ask:

Whose model has the largest volume? If we put the models in order of volume from smallest to largest, which order would they be in? What makes you think that? How sure are you? How could you check that out? (Establish that counting the number of centimetre cube blocks would tell them the volume)

What might be an efficient way to count the centimetre cube blocks? Is there a more efficient way? Can you count in a different way to check your first answer?

It's tempting to rush in and tell students about efficient counting strategies. Instead of doing that we can give them time to try their own strategies, observe their peer's strategies and refine their skills. We can always teach strategies later if students are still using inefficient counting techniques.

Connections between 'using units of measurement' and other maths content

There are many opportunities to connect to other content in the AC: Mathematics, when we use measurement as a starting point.

Here are just some of the possible connections that can be made:

Mathematics: Year 3	
Whilst working with units of measurement, connections can be made to:	**How the connection might be made:**
Recognise, model, represent and order numbers to at least 10 000.	Making metric measure number lines, making and recording metric measures.
Apply place value to partition, rearrange and regroup numbers to at least 10 000 to assist calculations and solve problems.	Refer to **Example 31**.
Model and represent unit fractions including 1/2, 1/4, 1/3, 1/5 and their multiples to a complete whole.	Counting area (and possibly volume) involving half and quarter squares. Also using language such as 'half/quarter of a litre', 'half/quarter of a metre' etc.
Identify symmetry in the environment.	When working with area (2D shapes) students might use line symmetry as an efficient way to calculate the area by counting squares on one side of the line of symmetry and doubling the count.
Collect data, organise into categories and create displays using lists, tables, picture graphs and simple column graphs, with and without the use of digital technologies.	Collect data that relates to units of measurements. For example, capacities of containers in your fridge.

Mathematics: Year 4	
Whilst working with units of measurement, connections can be made to:	**How the connection might be made:**
Recall multiplication facts up to 10 × 10 and related division facts.	Refer to **Example 8: Extension 1**.
Count by quarters, halves and thirds, including with mixed numerals. Locate and represent these fractions on a number line.	Counting area (and possibly volume) involving half and quarter squares. Also using language such as 'half/quarter of a litre', 'half/quarter of a metre' etc.
Compare the areas of regular and irregular shapes by informal means (Shape sub-strand).	Area is referred to twice in the Year 4 AC: Mathematics. It is referred to once in 'Using units of measure' and once in 'Shape'. The only difference being that informal units and irregular shapes are referred to in 'Shape'. Using irregular shapes and informal units when working towards an understanding of centimetre squares and metre squares, will address this element. Refer to **Example 4**, **Example 5** and **Example 10**.
Compare and describe two-dimensional shapes that result from combining and splitting common shapes, with and without the use of digital technologies.	Refer to **Example 1: Extension 1**.
Create symmetrical patterns, pictures and shapes, with and without digital technologies.	When working with area (2D shapes) the teacher can consolidate understanding about line symmetry.
Compare angles and classify them as equal to, greater than or less than a right angle.	When working with area (2D shapes) the teacher can consolidate understanding about right angles and ask students to identify angles that are less than/equal to, or greater than, a right angle.
Use simple scales, legends and directions to interpret information contained in basic maps.	Working with scales provides an opportunity to use units of length and area.
Construct suitable data displays, with and without the use of digital technologies, from given or collected data. Include tables, column graphs and picture graphs where one picture can represent many data values.	Collect data that relates to units of measurements. For example, capacities of containers in your fridge, or capacities of coffee cups marketed as small, regular, medium, large, jumbo, massive etc (from different coffee shops).

‘Using units of measurement’ from Foundation to Year 10A

The AC: Mathematics year level content descriptions shown here have been colour coded to highlight the following curriculum aspects of working with measurement:

Using informal units for direct or indirect comparisons
From **Foundation to Year 2** students focus on **informal units of measurement.**

Using standard metric units
From **Year 3 to Year 8** students develop their **understanding of metric units of measure.** This begins with the use of familiar metric units and extends to include a greater range of metric units and the flexibility to convert between different units.

Establishing and applying formulae
From **Year 5 to Year 10** students **establish and use formulae** of increasing complexity relating to perimeter, area and volume.

Estimating
Australian Curriculum references to **estimation** in relation to measurement lie entirely in the **Numeracy Continuum.**

Year level	‘Using units of measurement’ content descriptions from the AC: Mathematics
Foundation	Use direct and indirect comparisons to decide which is longer, heavier or holds more, and explain reasoning in everyday language.
Year 1	Measure and compare the lengths and capacities of pairs of objects using uniform informal units.
Year 2	Compare and order several shapes and objects based on length, area, volume and capacity using appropriate uniform informal units.
Year 2	Compare masses of objects using balance scales.
Year 3	Measure, order and compare objects using familiar metric units of length, mass and capacity.
Year 3	Use scaled instruments to measure and compare lengths, masses, capacities and temperatures.
Year 4	Compare objects using familiar metric units of area and volume.
Year 5	Choose appropriate units of measurement for length, area, volume, capacity and mass.
Year 5	Calculate the perimeter and area of rectangles using familiar metric units.

Year 6	Connect decimal representations to the metric system.
Year 6	Convert between common metric units of length, mass and capacity.
Year 6	Solve problems involving the comparison of lengths and areas using appropriate units.
Year 6	Connect volume and capacity and their units of measurement.
Year 7	Establish the formulas for areas of rectangles, triangles and parallelograms and use these in problem solving.
Year 7	Calculate volumes of rectangular prisms.
Year 8	Choose appropriate units of measurement for area and volume and convert from one unit to another.
Year 8	Find perimeters and areas of parallelograms, trapeziums, rhombuses and kites.
Year 8	Investigate the relationship between features of circles such as circumference, area, radius and diameter. Use formulas to solve problems involving circumference and area.
Year 8	Develop the formulas for volumes of rectangular and triangular prisms and prisms in general. Use formulas to solve problems involving volume.
Year 9	Calculate the areas of composite shapes.
Year 9	Calculate the surface area and volume of cylinders and solve related problems.
Year 9	Solve problems involving the surface area and volume of right prisms.
Year 10	Solve problems involving surface area and volume for a range of prisms, cylinders and composite solids.
Year 10A	Solve problems involving surface area and volume of right pyramids, right cones, spheres and related composite solids.

Numeracy continuum: Using measurement	
End Year 2	Estimate, measure and order using direct and indirect comparisons and informal units to collect and record information about shapes and objects.
End Year 4	Estimate and measure with metric units: estimate, measure and compare the length, temperature, volume, capacity and mass of everyday objects using metric units and scaled instruments.
End Year 6	Estimate and measure with metric units: choose and use appropriate metric units for length, area, volume, capacity and mass to solve everyday problems.
End Year 8	Estimate and measure with metric units: convert between common metric units for volume and capacity and use perimeter, area and volume formulas to solve authentic problems.
End Year 10	Estimate and measure with metric units: solve complex problems involving surface area and volume of prisms and cylinders and composite solids.

Source: ACARA, Australian Curriculum: Mathematics, Version 8.1

Do you want to feel more confident about the maths you are teaching?

Do you want activities that support you to embed the proficiencies?

Do you want your students thinking mathematically rather than just doing maths?

If you answered **yes** to any of these questions, then this resource is for you.

Packed full of examples, along with questions you can ask students as they engage in their learning, this resource supports you to develop confidence in teaching the Australian Curriculum: Mathematics.