Engineering

Developing an understanding of the metric system

Content and alignment

The metric measurement system is integrated into all aspects of engineering. Knowledge of the system and the ability to fluently move between units of measure, such as metres, centimetres and millimetres, is essential for learners pursuing a career in the engineering field. However, the system is often confusing for learners and this presents challenges for tutors delivering content in which a knowledge of the system is required.

Intent

The intent of this resource is to provide tutors with a teaching and learning sequence that introduces learners to the metric system in a way that leads to improved confidence and independence. This sequence emphasises the measure of length (metres, centimetres and millimetres), but can be used as a starting point for further learning in the areas of volume and mass. The sequence is suitable for learners who have limited experience with the metric system, but is likely to be useful to almost all learners.

This resource is not designed to replace existing programme approaches, but to provide tutors with additional learning content.

Sequence

There are four parts to this sequence. Learners will:

1. discuss what they already know about the metric system
2. make connections between the units
3. link the place value system to the measurement system
4. convert between metres, centimetres and millimetres.

1. *Discuss what learners know about the metric system*

Step one: Have learners break into groups and discuss what they know about the metric system. If prompts are needed the following questions may be useful:

- What are the metric units of measure and how do they relate to each other?
- When have you used the metric system in your home or work life?
- When would you be likely to use the metric system in an engineering workshop?

Step two: Ask learners to report on the discussions to the whole class. This initiates conversations and lets you, the tutor, get a rough idea of the knowledge in the room.

2. *Make connections between the units*

A. The cline

Have learners complete a cline using units of measure. Hand out the unit cards, and have groups place them in order from smallest to largest (See Engineering: Metric word cards).

An alternative is to draw a cline on a whiteboard and have groups take turns to write in where each unit fits.

Use this as an opportunity for a discussion. Note: When introducing measures of other dimensions such as volume (litres, millilitres), the units can be aligned with those shown here.
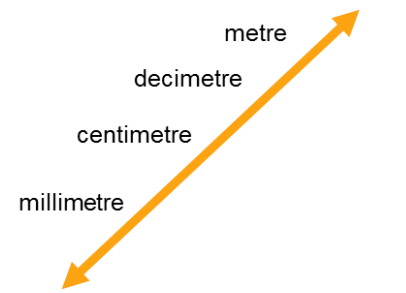

Fig 1. The cline

B. *Word analysis*

It is often useful to discuss with learners the meanings of the prefixes used in the metric system.

The base measurement is the metre. Therefore, the word 'metre' has no prefix. However, the other words do have prefixes that denote their size.

Kilo = 1000. Therefore, a 'kilometre' equals 1000 metres.

Ask learners to think of other words that have the prefix 'kilo'. Words include: kilowatt, kilogram, kilobyte and kilojoules.

Centi = 1/100 (one hundredth)

A 'centimetre' is 'one hundredth' of a metre. **Note:** The most commonly used prefix is 'cent', which means 100. Ask learners what other words have 'cent' as a prefix to generate words, and then link this to 'centi' which means one hundredth. Words may include: Centurion (Roman soldier in charge of 100 men, century (one hundred years) and cent (one hundred cents in one dollar).

Milli = 1/1000 (one thousandth)

A millimetre is one thousandth of a metre. Ask learners for words beginning with 'milli'. Words may include: millilitre (one thousandth of a litre), milligram, millipede (insect with what appears to be one thousand legs), millennium (one thousand years) and millisecond (one thousandth of a second).

The goal is to provide learners with additional ways to make sense of the structure of the metric system.

Key learning point: The metre is the 'base' measure. The others express their size in relation to the base.

Word Analysis

Word analysis refers to developing an understanding of words by breaking them up into component parts. These parts are usually suffixes, roots and prefixes.

3. Link the place value system to the measurement system

Now that learners understand that the centimetre and millimetre represent one hundredth and one thousandth respectively, the place value chart can be introduced.

Draw the place value chart on the board (place value charts can also be purchased or see Engineering: Place value chart) and ask learners the following:

"Now that we know that the units of measure are related to each other and the relationship is expressed in their name, where would they fit on the chart?"

You may need to remind learners that a 'metre' is the base measure and therefore 'one' or a 'unit'.

Units	Tenths	Hundredths	Thousandths
●			
●			

Learners should recognise that the 'units' column aligns with one metre, centimetres with hundredths and millimetres with thousandths.

Metres	Decimetres	Centimetres	Millimetres
Units	Tenths	Hundredths	Thousandths
●			
●			
●			
●			

It will be useful to discuss with learners the 'tenths' column in the metric system.

Although it does exist, the 'decimetre' is not widely used.

4. Convert between metres and millimetres

Activity: Saying numbers

Step one: Write three to five numbers into the place value chart and ask learners in groups to say the numbers as measurements to each other. Groups will then be asked to nominate a member to say the number aloud to the whole class. This may only take one round if learners are familiar with reading the measurements. If not, more rounds may be needed. This process helps learners understand the cumulative nature of reading a measuring tape (start with the biggest unit and move to the smallest).

Metres	Decimetres	Centimetres	Millimetres
Units	Tenths	Hundredths	Thousandths
1	0	2	4
2	0	4	5
7	0	1	9

For example, the number above would be expressed as "one metre and twenty-four millimetres". The second as "two metres and forty-five millimetres". This will help the learner use measuring tapes (see Engineering: Using a measuring tape) and ensures the learner is not simply saying the number without knowing what it represents.

In the next round the learners say the number as a decimal. For example*: "Seven, point zero one nine".*

Step two: The following step is to develop learners' ability to convert the above metre measurements to millimetre measurements

Ask learners:

Q: *What happens when we multiply a number by ten?*

A: The digits move one place to the left.

Q: *What happens if we multiply by 1,000?*

A   The digits move three places to the left.

   Demonstrate this to the learners.

   Converting a metre measurement into a millimetre measurement requires multiplying the number by 1,000, because 1 metre = 1,000 millimetres.

> **Key learning point:**
>
> The millimetre now becomes our 'unit'.

Ask learners:

Q: *Where will our numbers fit on the place value chart if we make our millimetres the 'unit'?*

A: They will move three spaces to the left.

Thousands	Hundreds	Tens	Units	Tenths	Hundredths	Thousandths
			1 •	0	2	4
1	0	2	4 •			

Fig 2. Metres multiplied by 1000 results in millimetres

Activity: Converting metres to millimetres

Write 3 to 5 measurements into the place value chart as metres, and have learners convert them to measures of millimetres in their groups. Allow learners to use the place value chart to do this. They will quickly realise that they are able to move the numbers three columns over. Before long the learners will skip this step and be able to read the number. Have learners say the measures correctly using the appropriate unit measure. For example:

"One point zero two four metres is equal to one thousand and twenty-four millimetres."

Model the correct way to read the measurement. This may seem like a lot of effort but this practice will help consolidate the information for learners unfamiliar with the process.

Tips: This activity is often more effective if broken into small doses and applied every day. Some tutors have dedicated five minutes in the morning and five directly after lunch to this activity. Place value sheets, or small white boards can be used, and larger place value charts can be pinned to the wall. In many cases the tutor writes a measure as a metre (1.034 m.) on the white board, or place value chart, and asks learners to write the number as millimetres. Learner quickly multiply the number by 1000 (moving the digits three places to the left) and then read the number aloud.

Summary

Understanding and using the metric system is often a major learning curve for many learners. Yet, learners will be engaging with the system throughout their lives. The sequence used in this resource assumes learners have little experience with metric measurements. It has four parts to the sequence in which learners will:

1. discuss what they already know about the metric system
2. make connections between the units
3. link place value system to the measurement system
4. convert between metres, centimetres and millimetres

This sequence works well with resource Engineering: Using a measuring tape.