Engineering

Developing an understanding of area

Content and alignment

Calculating and expressing the area of a surface in square centimetres or millimetres is an integral skill for all engineers. Engineers are expected to work with these measurements easily and fluently. Yet the concept that flat surfaces of all shapes are measured in squares can be a difficult concept for learners to grasp. Likewise, the knowledge that base multiplied by length ($a = b \times l$) is often memorised rather than understood, contributing to further difficulties when coming to understanding the concept of volume. This resource provides a teaching and learning sequence that will support learners' understanding of area.

Intent

The intent of this resource is to provide learners with a practical and visual example of how area is used and calculated. It transitions learners from understanding the concept to understanding how the formula (a = b x l) works. The sequence is supported with other teaching and learning materials (see supporting resources on pp 4-7). Depending on the skill level and prior knowledge of your learners you may move through the sequence quicker.

Sequence

There are five parts to this sequence:

1. Discussing how area is measured
2. Measure area using a non-standard square
3. Using rows and columns to calculate the area
4. Calculating area using only numbers
5. Introducing standard units of measure (centimetres and millimetres).

1. Discussing how area is measured

Step one: Have learners work in small groups to discuss why and where they will use the concept of area. Following this, ask learners to share their ideas with the whole class and make connections to the role of area in engineering. You may want to discuss workplace demands, the use of plans, and programme requirements. Visual examples of the use of area are also useful (see p.4).

Step two: Next, have learners discuss what the area of an object is, how it is expressed, and what it is measured in (e.g., square metres, centrimetres, millimetres).

Have groups feed back to the class and emphasise that area expresses how many squares of a certain size will fit within an area.

2. Measure area using a non-standard square

Hand out a non-standard square (p.5) to each of the learners. The use of a non-standard square is to contribute to the development of conceptual understanding before introducing centimetres and milimetres. Hand out two pieces of card (p.6).

Have learners use the non-standard square to measure the area of the two cards. Use this opportunity to observe learners. Do they measure the sides and multiply, or do they attempt to measure the entire piece of card with the square?

Once learners have done this, ask them for their answers and write them on the board in order, from smallest to largest. Suggest a double check if the answers are varied. Next, ask the learners if there was a quick way to do this task and if there was a slow way. In most cases, learners will have only measured the base and height and will then have multiplied. Ask a learner who has done this to explain why it it is faster and how it works.

3. Use rows and columns to calculate the area

Step one: Hand out the incomplete area sheet (p.7) and ask learners to fill in the missing squares.

Ask the learners if there is an easy way to do this. The easiest way to this is to continue the lines from the existing columns and rows. Surprisingly, you may find that some learners who scored at the lower steps in the Numeracy Assessment may not immediately see this approach.

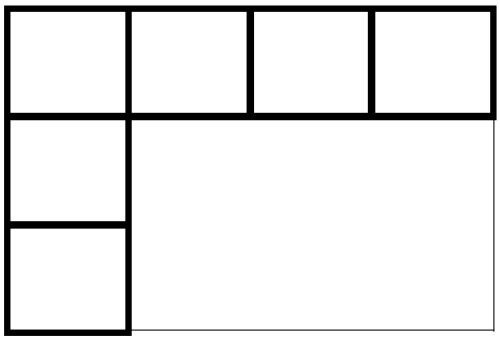


Fig 1. Incomplete grid

If this is the case, be sure to demonstrate to learners this approach or have other learners do so. The learning point is that the pattern is consistent and that the existing squares can be used to find the others.

Step two: Once these sheets are complete ask the learners to discuss whether you can tell how many squares will be in the area without drawing in the squares.

Note: This may seem like a simple question and perhaps too easy for your learners. However, it is likely that for some learners (possible the quiet ones) this process opens up the concept of area.

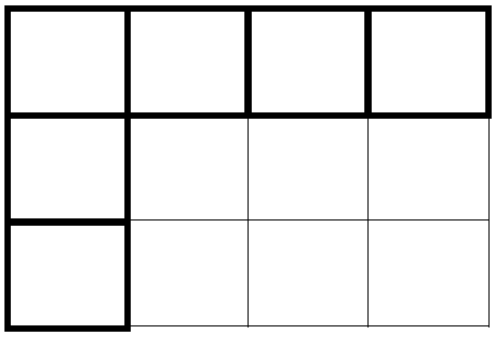
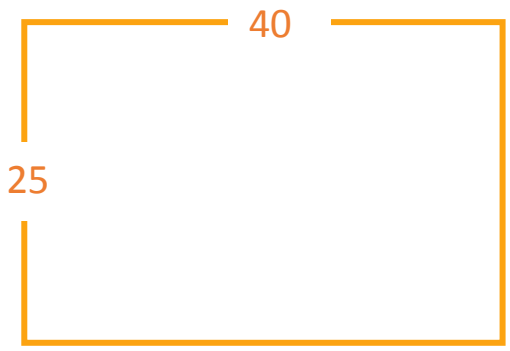


Fig 2. Completed grid by extending existing lines

4. Calculate area using numbers only

Once the learners are able to calculate the total amount of squares in an area without drawing the squares in, show learners some standard plans (such as the one on p. 4) and ask them to discuss what the numbers represent.



Learners will become aware that the numbers represent squares. Have learners continue to calculate the area of these surfaces and if required have them draw in the squares.

5. Introduce standard units of measure (centimetres and millimetres)

At this point learners should be introduced to the standard unit measure and the notation for this. For example, $4cm^2$ or $220mm^2$.

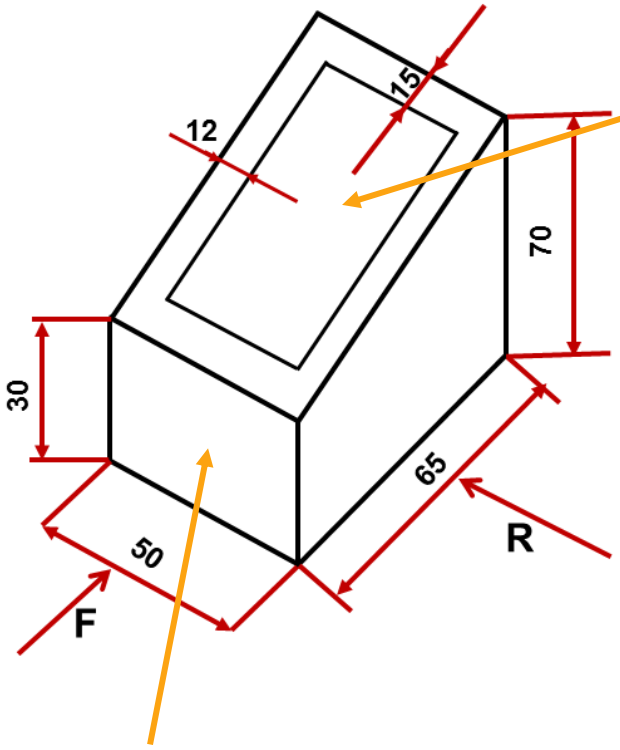
Learning and teaching sequences for developing the learners' understanding of units of measure can be found in **Engineering: Developing an understanding of the metric system.** However, a good follow-on for this activity is to introduce a physical square centimetre in order to provide a visual model. This can be cut from paper (or have learners measure and cut it themselves). Learners can discuss this, and then use the square cm to measure the area of a small surface. When completed, ask learners to discuss how a ruler could speed this process up. Additionally, ask learners to discuss how many square millimetres will fit into the square centimetre. Make links between the formula for area and the measures found through the use of the ruler.

Summary

Many learners benefit from seeing how the area of a surface is found to support their understanding of the formula **area = base x length**. This sequence begins with a discussion on what area is and what its uses are. Learners then develop a conceptual understanding by measuring using a non-standard square. Learners will begin to realise that the area of a surface can be found more efficiently through multiplying the rows by the columns, and understand that these are represented by the base and length numbers. Finally, learners are made aware of standard units of measure, centimetres and millimetres.

Example of the use of area

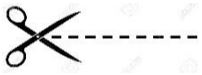
Example of a talking point regarding the uses of area and its role in engineering.



What unit measures are most likely used?

Non-standard square

Cut into 20 squares
One square for each learner



Example of the use of area

Surfaces to calculate area using non-standard square on page 5

Incomplete area sheet