Challenging topics

Calculating scales for scale drawing

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Introduction

Learners are confronted with scales in a range of situations. They might be required to make a scale drawing when planning a nursery or a computer room, or designing a stage set. Construction and the built environment and Engineering learners will often be required to interpret scale drawings in the course of buying materials, installing kitchens and bathrooms, or fabricating a component for an engineering application.

This session is intended to address the underpinning skills for all these applications but particular examples may be included where they are relevant to the course being studied.

Learning objectives and outcomes

To help learners to:

- understand the meaning of scales written in the form 1:x
- carry out calculations involving scales using a variety of units.

Resources required

For each learner you will need:

- a mini whiteboard
- a pair of scissors if individuals are going to cut up cards.

For each small group of learners you will need:

- Sheets 1, 4, 7, 8
- Card sets 2, 3, 5, 6 cut up (this could be done by the learners).

Starting points

Learners should already be familiar with a variety of units, which will depend on the vocational area. For example, Society, health and development (SHD) learners will be familiar with simple metric measurements of length: millimetres, centimetres and metres, while CBE learners might well be familiar with a range of metric and imperial measures. All should be familiar with measurements up to 30 centimetres using the equivalent of a 12 inch rule.

Planning learning in multiple environments

As teachers*, we spend a lot of time planning the learning experience in our classroom, workshop or training area. However, it is worth considering how we can encourage our learners to explore learning in a wider range of settings. Pointing learners in the direction

of a relevant TV programme, a newspaper article or even an advert can bring learning alive. There might be opportunities to ask learners to observe something on the way to work or college, to reflect on an aspect of their own social or home lives or to apply a newly learned skill in a workplace situation. All these can help the learning process, making it more real and relevant.

Mathematics occurs everywhere in our lives; helping the learners to start to recognise the occasions where it pops up and to incorporate them into their own thinking is a step towards real and useful learning.

> * We use the word 'teacher' as a generic term to include teachers, tutors, trainers, lecturers and instructors in the further education (FE) system.

Time needed for this session

About one hour.

Suggested approach

Stage 1: Beginning the session

Start by asking the group what a scale of 1:2 might mean. Write a selection of their responses on the whiteboard. Discuss the concept of representing a measurement in real life by a different measurement on a scale diagram.

You might like to try (with the learners using their mini-whiteboards for their answers) a few true or false questions such as:

- A scale of 1:5 implies that 3 cm on the scale drawing represents 15 cm in real life… true or false?

Always ask for an explanation before agreeing or disagreeing with the answer presented. Encourage the learners to talk through their thinking.

Try different measurements and different scales, moving on to the more difficult questions where we start with the real life measurement and work out the scale measurement. For example:

- A scale of 1:10 implies that 200 cm on the scale drawing represents 10 cm in real life… true or false? Again, ask for an explanation, encouraging learners to talk through their thinking.

You might even like to move onto a few questions where you give the two measurements working out the scale.

> **Comment**
>
> It does not matter which unit we are using providing we use the same unit for both measurements.
>
> Ask the group to describe when they need to divide and when to multiply. So, for example, with a scale of 1:10, we need to divide a real measurement by 10 to get the scale measurement, but multiply by 10 to go the other way.

Stage 2: Scale activity

Working in groups

Divide the group into pairs.

Use Sheets 1, 2 and 3.

The cards on Sheets 2 and 3 should be cut up (this could be done by the learners).

The task is to place the cards onto Sheet 1 so that the scales are correct.

There are lots of possible solutions, and learners finding the task straightforward should be encouraged to look for interesting solutions. Learners should be encouraged to take turns when placing the cards and explain, for each card pair that is placed, how they reached that decision.

Extending the learning

There are two blank spaces on Sheet 1. Learners can be encouraged to invent their own scales, setting additional tasks for their partner to solve.

There are also blank cards, and learners might want to add cards of their own to complete the task. These also allow you to set additional tasks to help support learners who are finding it difficult by providing some additional straightforward tasks.

Stage 3: Scales with different units activity

Working in groups

This is a more complex version of Task 1, using Sheets 4, 5 and 6. The cards include a mixture of units. Many of the solutions could be fairly straightforward if the learners choose to use the same units for both the actual and the scale measures. However, learners who need a challenge could use cards with a mixture of units to solve the puzzle. You might need to remind them of the conversion factors.

Putting the learning into context

There are examples of scales being used in many vocational areas. In particular these skills are needed every time you need to produce or interpret a scale diagram, map or plan. Learners in Information Technology (IT) will come across this topic when planning a computer room or interpreting a diagram showing the ideal ergonomic seating position for a worker at a workstation. Society, health and development (SHD) learners might need these skills when planning a nursery, or furnishing a care home. Plans, blueprints and diagrams form an important part of much work in Engineering and Construction.

Sheet 7: Practical questions contains just a few practical examples for the learners to measure and work out the scale that has been used. You might like to substitute some pictures of your own that relate to the vocational area of the course.

Sometimes learners need to know about scale rulers. The task in **Sheet 8: Scale rulers** is designed to help learners understand the principles behind the use of a scale ruler by constructing and using one of their own. This activity would be especially useful with learners in Engineering and CBE. Scale rules are used extensively in both these industries and the ability to understand and use them effectively is a valuable skill. Creative and media learners might also find this sheet useful since scale rulers are often used in set design when designers need to draw a scale diagram or model of a set for a theatrical production.

Stage 4: Reviewing the learning

Whole group discussion

Not all the learners will complete all the tasks, but when you are satisfied that the learners have grasped the ideas and processes, bring the whole group together again. Ask the learners to spend a few minutes writing down the main points of the session and the process that they have been using. Select some learners to read out their points and through discussion move towards an agreed set of points. These can then be written on the whiteboard.

If there is time, you might want to finish with a quick quiz using the mini-whiteboards.

For example: write the scale 1:5 on the board. Ask the group questions such as:

*   If I have a measurement of 10 mm on my scale diagram what would the measurement be in real life? What about 20 mm? 50 cm? and so on.
*   What measurement on the scale diagram would I draw to represent 5 m in real life? What about 10 cm? 20 cm? 100 mm?

Repeat this process with a range of different scales until you are sure that the learners understand what the scale means and how to do the calculations in both directions.

Meeting the needs of all learners

The tasks are all designed to allow learners to work at their own levels in tackling the problems. As learners are taking turns on each task, they can select an example of their own. Our experience from the pilot indicates that, in general, learners will choose tasks that are more challenging than teachers would set for them.

Task 2 is a much more complex task than Task 1. Some learners might want to progress straight to Task 2 but only allow this if you really are sure that they have mastered the skills required for Task 1.

Sheet 1: Scales

Scale measurements	Ratio	Real measurements
	1:2	
	1:3	
	1:5	
	1:10	
	1:20	
	1:30	
	1:50	
	1:100	
	1:500	
	1:1000	

Sheet 2: Scale measurement cards

1	**2**	**2**
2	**3**	**5**
5	**10**	**10**
15	**20**	**30**
40	**45**	**50**
50	**60**	**100**
100	**150**	**150**
200	**200**	**300**
300	**400**	**500**
600	**800**	**1000**
5000	**20000**	**30000**

Sheet 3: Real measurement cards

1	2	2
2	3	5
5	10	10
15	20	30
40	45	50
50	60	100
100	150	150
200	200	300
300	400	500
600	800	1000
5000	20000	30000

Sheet 4: Scales

Scale measurements	Ratio	Real measurements
	1:2	
	1:3	
	1:5	
	1:10	
	1:20	
	1:30	
	1:50	
	1:100	
	1:500	
	1:1000	

Sheet 5: Scale measurement cards mixed units

1 mm	**2 mm**	**2 mm**
2 cm	**3 cm**	**5 mm**
5 cm	**10 mm**	**10 cm**
15 mm	**20 mm**	**30 mm**
40 mm	**45 mm**	**50 mm**
50 cm	**60 mm**	**100 mm**
100 cm	**150 cm**	**150 cm**
200 cm	**200 mm**	**300 cm**
300 mm	**400 mm**	**500 m**
600 cm	**600 mm**	**800 cm**
1000 cm	**1000 m**	**1000 mm**

Sheet 6: Real measurement cards mixed units

2 mm	**2 cm**	**2 m**
2 m	**3 cm**	**5 mm**
5 cm	**10 mm**	**10 cm**
15 mm	**20 cm**	**30 cm**
40 cm	**45 cm**	**50 cm**
50 m	**60 cm**	**100 cm**
100 cm	**150 cm**	**150 m**
200 mm	**200 cm**	**300 cm**
300 m	**400 cm**	**500 cm**
600 cm	**800 cm**	**1000 mm**
5000 cm	**20000 m**	**30000 mm**

Sheet 7: Practical questions
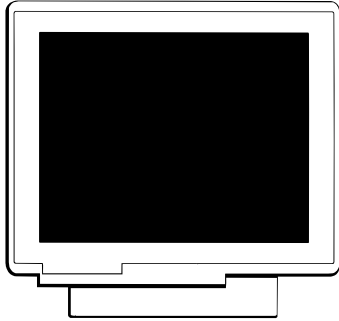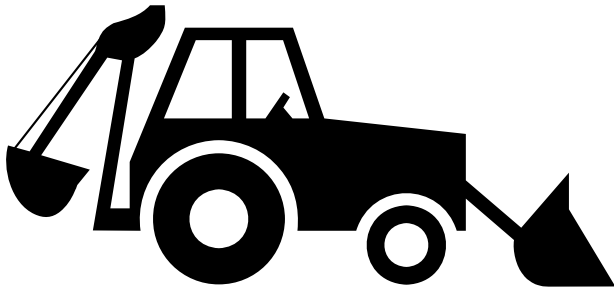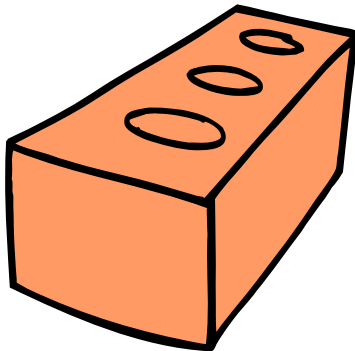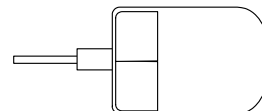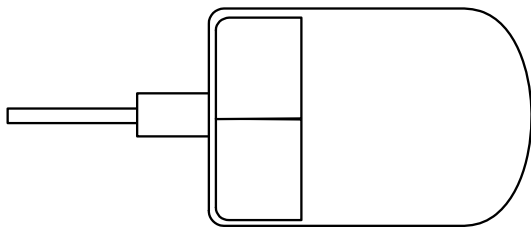
|	
	The scale is 1:
	The scale is 1:
	The scale is 1:
	The scale is 1:

Sheet 8: Scale rulers

If someone needs to carry out lots of work with scale diagrams, they will often use a scale ruler to help them do the job. Scale rulers are often used by architects and engineers in particular.

A scale ruler is simply a scale that is marked off in the 'real' measurements so that it can be used to draw directly to scale or measure directly from a scale diagram.

Here is an example of a scale ruler for a scale of 1:10.
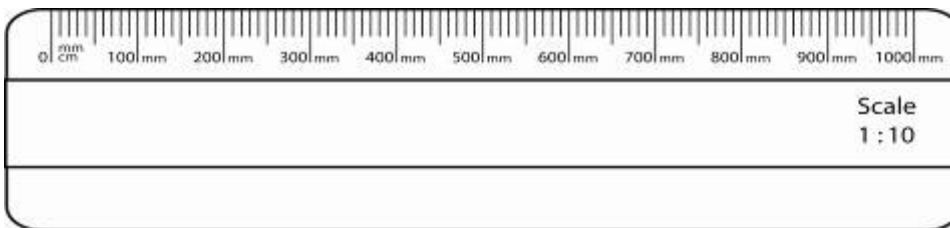
You will see that 1 cm on the rule is marked as 100 mm. How would you check that this is correct for a scale of 1:10?

It is easy to use. If, for example, you are designing a kitchen and the dishwasher is 600 mm wide, then to draw this length on your scale diagram you use the rule and mark off a length of 600 mm on the scale, and you have a line on the drawing that is 6 cm (or 60 mm) long.

Task 1

Construct a scale rule for yourself using a scale of 1:20.

You might find the following table helpful in calculating the graduations that you need.

Measurement on the ruler: cm	1	2	3	4	5	6	7	8	9	10
'Real' measurement: cm	20						140			

Task 2

Use your ruler to construct a 1:20 scale drawing of the room you are in.