Monster's feet

Reasoning in the classroom
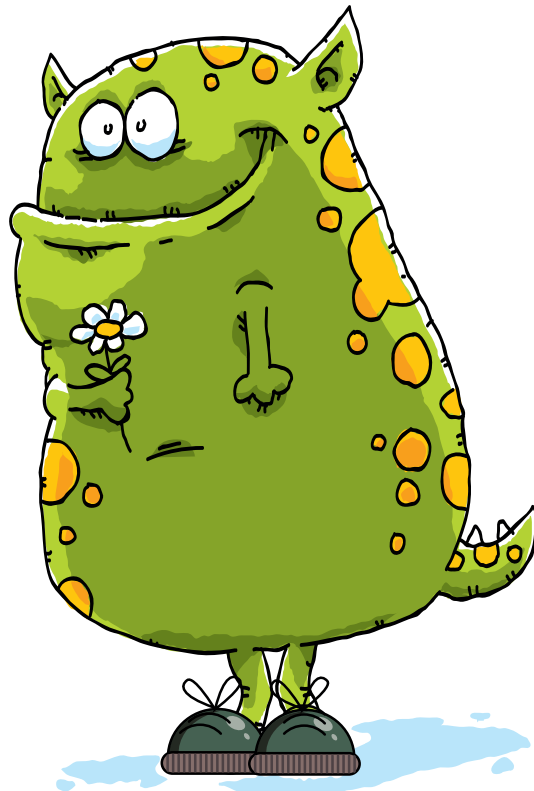
Support materials for teachers

Year 6

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Welsh Government

Year 6 Reasoning in the classroom – Monster's feet

These Year 6 activities focus on numerical and spatial reasoning. The first activity was included in the 2015 National Numeracy Tests (Reasoning). This is followed by one further activity.

Activity 1

Monster's feet
Learners work out the size of shoes that a monster would need.
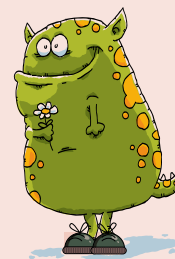Includes:
- Monster's feet question
- Markscheme

Activity 2

Monster's steps
Learners explore patterns created by the very strange way in which the monster moves.
Includes:
- Explain and question – instructions for teachers
- Whiteboard – One step
- Whiteboard – Two steps
- Resource sheet – Show steps A
- Resource sheet – Show steps B

Reasoning skills required

Identify

Learners select appropriate mathematics and techniques to use.

Communicate

They present their work orally, pictorially and in written form, explaining their reasoning.

Review

They interpret results within the context of the problem and consider whether answers are sensible.

Procedural skills

- **Four rules of number**
- **Number patterns**
- **Compass directions**
- **Lines of symmetry/rotational symmetry**
- **Coordinates (including negative coordinates)**

Numerical language

- **Length**
- **North/east/south/west**
- **Minimum**
- **System**
- **Lines of symmetry**
- **(Order of) rotational symmetry**
- **Square grid**
- **Coordinates**
- **Negative**

Monster's feet

Activity 1 – Monster's feet

Outline

This Year 6 activity uses real-life data about shoe sizes, but in a fantasy context. Learners are given the length of three children's feet and their shoe sizes, and are asked to work out the shoe size that a monster would need, given the length of his feet.

This is a demanding multi-step activity which requires learners to identify and apply their own method.
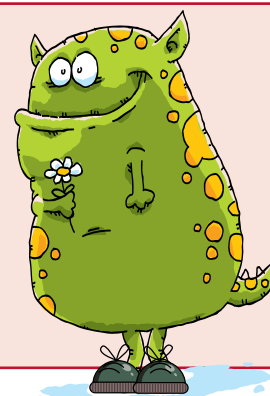
You will need

Q **Monster's feet question**
One page for each learner

M **Markscheme**

Length of foot
20.8 cm

Shoe size **1**

Length of foot
21.6 cm

Shoe size **2**

Length of foot
22.4 cm
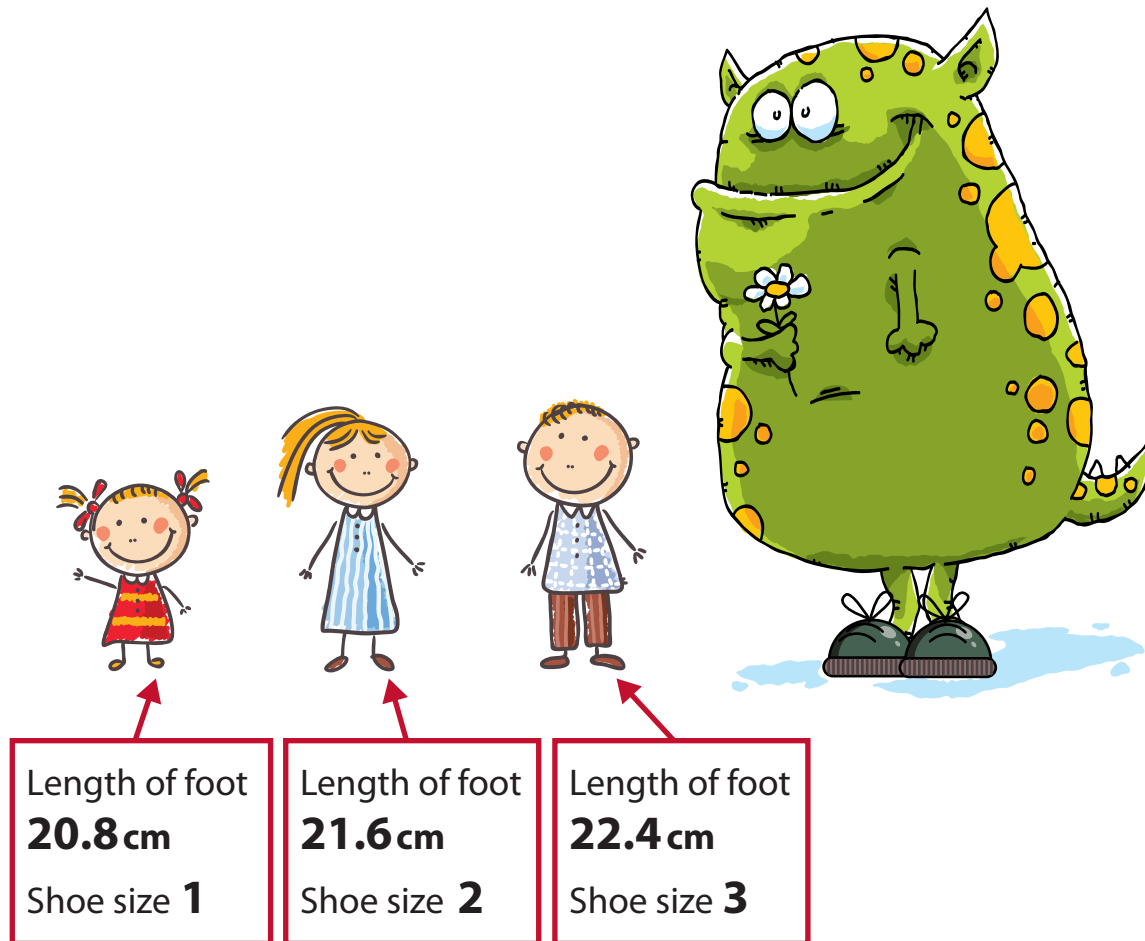
Shoe size **3**

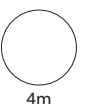The length of the monster's foot is **46.4 cm**.

What shoe size would he need?

Shoe size

4m

Activity 1 – Monster's feet – Markscheme

Marks	Answer
4m	**33**
Or 3m	Shows a method **including division** that would lead to 33 if calculated correctly Or Shows a method based on **counting on in 5 or more shoe sizes** that would lead to 33 if calculated correctly
Or 2m	Gives the answer **32**, **31** or **30** Or Shows ÷ **0.8** Or Shows any of the following: 46.4 – 22.4 46.4 – 21.6 46.4 – 20.8 46.4 – 20 Or Shows an intent to **count on in 1 or more shoe sizes**
Or 1m	Shows or implies **0.8**

◄ **Example of a method including division:**

22.4 – 21.6 = 0.8
46.4 – 22.4 = 24
24 ÷ 0.8 = 30
30 + 3 = 33

◄ **Example of a method based on counting on in 10 shoe sizes:**

1 shoe size = 0.8,
so 10 shoe sizes = 8
shoe size 3 = 22.4
shoe size 13 = 30.4
shoe size 23 = 38.4
shoe size 33 = 46.4

◄ **The number of 0.8's needed to get to 46.4 from shoe sizes 1, 2 or 3**

◄ **Difference between the monster's foot and shoe sizes 3 or 2 or 1 or 0**

Activity 1 – Monster's feet – Exemplars

|	
It is 24cm bigger than the boy. Each shoe is 0.8cm and I know there are 30 of them in 24 because I did do divide on the calculator and so that is how I know that it is 30 bigger than the boy so that is how I did 33 and I did that in my head. Shoe size **33**	**Correct; 4 marks** **Efficient method** The response shows insight into the problem – the method is efficient, though the description would benefit from being more concise!
2 shoes = 1.6 5 = 24 17 = 33.6 29 = 43.2 7 = 25.6 19 = 35.2 31 = 44.8 9 = 27.2 21 = 36.8 33 = 46.4 11 = 28.8 23 = 38.4 13 = 30.4 25 = 40 15 = 32 27 = 41.6 Shoe size **33**	**Correct; 4 marks** • This learner counts on in 2 shoe sizes which is time-consuming and therefore inefficient. Had there been any slips, this learner would have scored 2 marks only since for 3 marks the method must involve counting on in at least 5 shoe sizes.
Shoe size **32**	**Shows 32; 2 marks** • The lack of numerical communication is disappointing but 32 implies a correct method, without taking into account shoe size 1
It goes up by 0.8 so I did 46.4 ÷ 0.8 = 58 so that is my answer. Shoe size **58**	**Shows ÷ 0.8; 2 marks** • This learner shows some understanding but has forgotten that shoe sizes start at foot length 20.8cm.
20.8 → 0.8 → 21.6 → 0.8 → 22.4 22.4 → +8 → 30.4 - size 13 Shoe size	**Intent to count on in 1 or more shoe sizes; 2 marks** • The second line of this working shows that the learner has counted on, once, in 10 shoe sizes. Had the method been continued a further mark would have been available.
23.2 = 4 24.0 = 5 25.8 = 6 26.6 = 7 Shoe size	**Intent to count on in 1 or more shoe sizes; 2 marks** • Despite the numerical error and incomplete working, steps of 0.8 are clearly implied.
23.2 = 4, and 23.2 + 23.2 = 46.4 So it is shoe size 8 Shoe size **8**	**Implies 0.8; 1 mark** • 23.2 (from 22.4 + 0.8) implies 0.8, but the method from then is incorrect.

Monster's steps

Activity 2 – Monster's steps

Outline

This Year 6 activity continues the fantasy theme of monsters. The monster takes steps that mirror the moves of a knight on a chessboard and learners investigate the minimum number of steps needed to reach various positions on a grid.

The activity offers a context for teaching, practising or assessing understanding of coordinates.
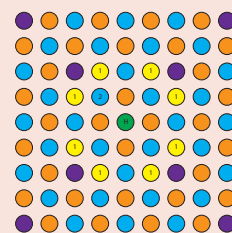
You will need

WB   **Whiteboard – One step**

WB   **Whiteboard – Two steps**

Colouring pencils/felt-tipped pens

Each pair/small group will also need:

R   **Resource sheet – Show steps A (less demanding)**
One page for each pair/small group

Or

R   **Resource sheet – Show steps B (more demanding)**
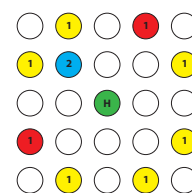One page for each pair/small group

Activity 2 – Monster's steps

Explain

Show **One step** on the whiteboard and say that although the monster is big he is frightened of all sorts of things. To fool anyone that might be watching, every time he takes a step away from his home he does so in a very strange way. Explain that H shows the monster's home, and the yellow circles show where the monster could be after just one monster step from his home. Ask learners to talk with the person next to them – can they describe one monster step? *(The monster always moves 2 circles in one direction followed by 1 circle in another – not diagonal, and not moving back on himself. So, he can move 2 circles north or south, followed by 1 circle east or west, or 2 circles east or west, followed by 1 circle north or south.)*

Once learners understand the movements *(link to the moves of a knight on a chessboard if appropriate)*, show **Two steps**. The monster has taken two steps from his home and is now on the blue circle. Which of the yellow circles could he have been on after one step? *(The red circles on the diagram opposite)*

Give each pair/small group a copy of **Show steps A** or **Show steps B** *(according to ability)* and ask them to find the minimum number of steps needed to reach every circle on the grid. *(The circles that can be reached in 1 step and one of the circles that can be reached in 2 steps are already shown.)* To begin with, learners should write in the number of steps in pencil so that mistakes can be corrected. Learners should then choose a colour for each set of circles that share the same minimum number of steps, e.g. 1 step, 2 steps, etc., and colour in their diagram. *(The solution can be found at the end of the section entitled 'Question'.)* Once complete, discuss the outcomes and learners' approaches, using the questions below to explore the symmetry within the resulting pattern.

Go back to **Two steps** on the whiteboard. Ask learners to suppose that a square grid is placed on the diagram. The centre of the circle showing the monster's home is at (0, 0) *(write on the whiteboard and draw the axes)* and the centre of the circle next to, and due east, of the monster's home is at (1, 0) *(write on the whiteboard)*. Go through two or three other points identifying their coordinates, including ones with negatives.

Ask learners to use their resource sheet, or give them a clean copy. Say that the monster takes 3 steps to move from (0, 0) to (3, –2). What routes could the monster have taken? *(e.g. (0, 0) to (–1, –2) to (1, –3) to (3, –2))* Ask them, in their pairs/small groups, to find as many routes as possible. If time permits, let each pair/small group set challenges for other pairs/small groups, giving the start and finish coordinates and the number of steps, and asking them to work out the different routes that could be taken.

Question

■ How did you find all the 2-steps? Did you have a system? *(Start from the 1-steps)* To go north 1, how many steps does the monster need to take? *(3)* How are you certain it is not possible to reach north 1 in fewer steps?

■ How can you check your work? *(Symmetry)* How does symmetry help you work efficiently? *(Work out part of the diagram and then repeat.)* How many lines of symmetry are there? *(Four, the same as the lines of symmetry in a square)* What about rotational symmetry? *(The diagram has rotational symmetry of order 4, as does a square.)*

Show steps A or **B** (*solutions*)

Reduce as necessary for sheet A
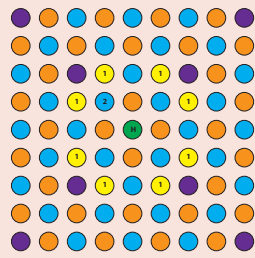
Key:

green circle – monster's home

yellow circles – one step

blue circles – two steps

orange circles – three steps

purple circles – four steps

N

○	○	○	○	○	○	○
○	○	1	○	1	○	○
○	1	2	○	○	1	○
○	○	○	H	○	○	○
○	1	○	○	○	1	○
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