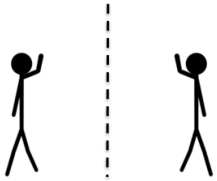
COMMAND THE ROBOT 1

What do you know about robots? What are drones? Are driver-less cars actually robots?

What do you think about robots that move around warehouses to pick up and carry loads from place to place and about robots that control complicated machinery in factories?

What do you think about robots that mow lawns and clean floors?



What happens when you look in a mirror? If you touch your right ear what does your mirror image do? Try it.

If you wink with your left eye does your image seem to wink with his left eye or his right eye? Try it?

Try some other actions and describe what you did and what your image did.

REFLECTIONS

Work with a partner and face each other. Make 3 different actions and your partner must copy you as if he or she is your image in a mirror. If you touch your nose with your right hand then your partner must do the action of a mirror image, but with which hand?

Then your partner must do 3 different actions and you must copy them as if you are the image in a mirror.

GROUP ACTIVITY

The group can be a whole class or a smaller group.

You will learn something about how people write codes to program computers to control robots. To start with you have to pretend to be a robot yourself and you must follow commands. These are commands in the Logo language which is one of many programming languages.

The group will need to be in a space outdoors, in a wide corridor or in a big room such as the school hall.

Your teacher, group leader or another learner will give the following commands one by one, but not in this order, and you must obey the commands.

ROTATIONS

RIGHT 360 tells you to TURN through a WHOLE turn 360^{o} clockwise (to your right) and to end up facing the direction you faced at the start.

LEFT 360 tells you to TURN through a WHOLE turn 360^{o} anti-clockwise (to your left) and to end up facing the direction you faced at the start.

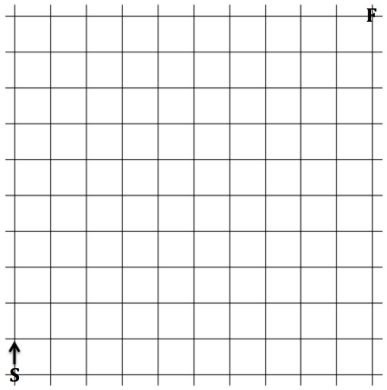
RIGHT 180 tells you to TURN through a HALF turn 180° clockwise (to your right) and to end up with your back to the direction you faced at the start.

LEFT 180 tells you to TURN through a HALF turn 180° anti-clockwise (to your left) and to end up with your back to the direction you faced at the start.

RIGHT 90 tells you to TURN through a QUARTER TURN 90° to your right (clockwise).

LEFT 90 tells you to TURN through a QUARTER TURN 90° to your left (anti-clockwise).

TRANSLATIONS



These are translations:

FORWARD 7 BACK 2 tells you to take 7 steps forward and 2 steps back.

RIGHT 90 FORWARD 5 LEFT 90 tells you:
make a quarter turn clockwise,
take 5 steps forward
then make a quarter turn anticlockwise
so you face the same way as at the start.

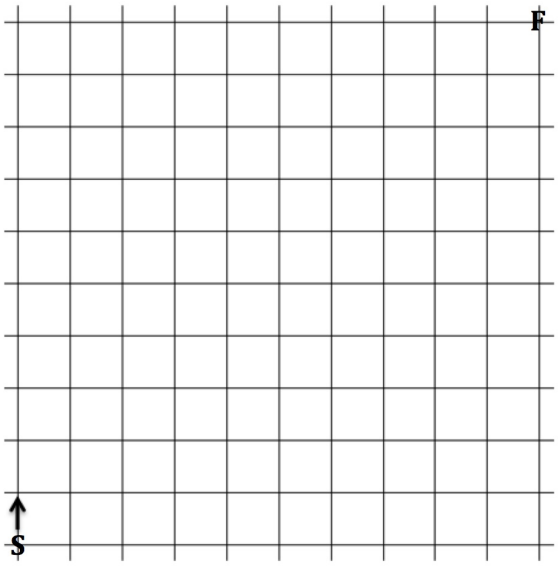
COMMAND THE ROBOT

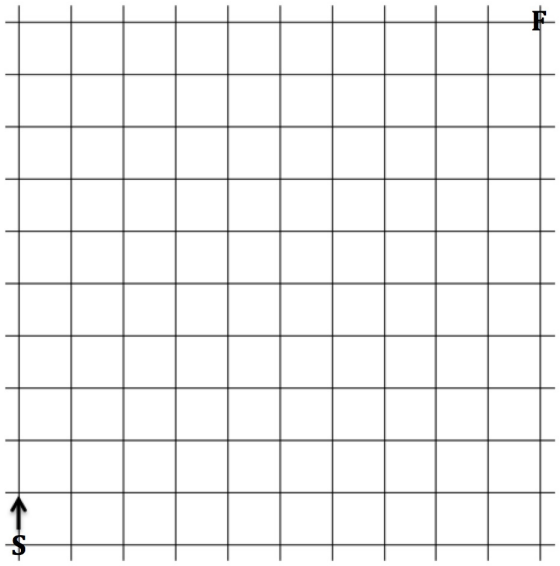
Imagine you have a robot at point S of this grid facing in the direction of the arrow and that each square represents one step.

Draw a path on a copy of this grid to go from S to F making 5 turns on the way and describe this journey.

Write a list of commands to make your robot go from S to F making 5 turns on the way and then write the code.

Then draw his path to go from S to F making 9 turns on a copy of this grid, describe his journey and write the code.





HELP

The 4 commands FORWARD, BACK, RIGHT and LEFT enable you to write code to make the robot move along the gridlines.

You might find it easier to start by drawing a path on the grid to get from S to F making exactly 2 turns on the way and then make a list of commands to make the robot go along your path. After that try a route with 5 turns.

NEXT

Draw a pattern of connecting straight line segments on the grid and write the code for a robot to start at S and walk along all the lines in your pattern.

Resources: Have a photocopy of the grid or draw your own copy using squared paper if you have it available,

NOTES FOR TEACHERS

SOLUTION

Reflections: It is important that learners look at themselves in a mirror and understand that what they do with their right hand their image appears to do with their left hand and vice versa. Also they should see that the image is the same distance to other side of the mirror as they are in front of the mirror.

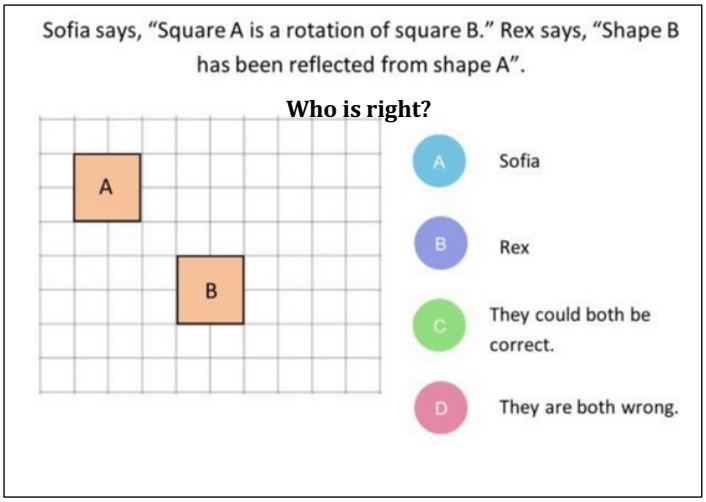
There are many solutions that move the robot from S to F with 5 turns on the way. This is one:

FORWARD 4 RIGHT 90
FORWARD 4 LEFT 90
FORWARD 4 RIGHT 90
FORWARD 4 LEFT 90
FORWARD 2 RIGHT 90
FORWARD 2

DIAGNOSTIC ASSESSMENT This should take about 5–10 minutes.

Write the question on the board, say to the class:

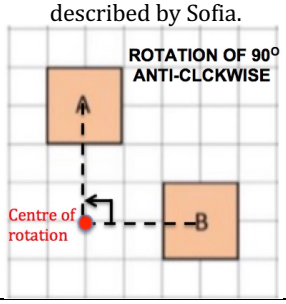
"Put up 1 finger if you think the answer is A, 2 fingers for B, 3 fingers for C and 4 fingers for D".



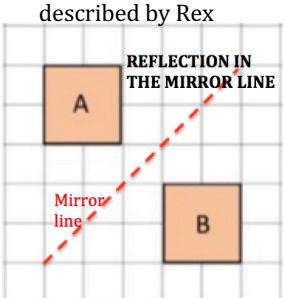
1. Notice how the learners respond. Ask a learner who gave answer A to explain why he or she gave that answer. DO NOT say whether it is right or wrong but simply thank the learner for giving the answer.
2. It is important for learners to explain the reasons for their answers. Putting thoughts into words may help them to gain better understanding and improve their communication skills.
3. Then do the same for answers B, C and D. Try to make sure that learners listen to these reasons and try to decide if their own answer was right or wrong.
4. Ask the class to vote for the right answer by putting up 1, 2, 3 or 4 fingers. Notice if there is a change and who gave right and wrong answers.
5. If the concept is needed for the lesson to follow, explain the right answer or give a remedial task.

The correct answer is C
they are both correct.

Transformation as described by Sofia.



Transformation as described by Rex



Why do this activity?

This activity has real life relevance as it introduces learners to discussion of the role of robots in the modern technological word. Learners are introduced to the idea of coding to control a computer that in turn controls a robot. The activity is suitable for a wide age range of learners and a wide ability range. Engaging in 'people maths' by pretending to act as a robot and following commands seems like a game to learners. It helps them to learn some simple programming commands and ideas of the transformations of reflection, rotation and translation. Using angles is optional as the rotation commands can be given as quarter turn, half, turn and full turn.

Learning objectives

In doing this activity students will have an opportunity to:

- meet the concepts of reflection, rotation and translation (or to reinforce understanding of these transformations);
- meet (or reinforce) concepts of angle measurement, right and left and/or the words clockwise and anti-clockwise;
- begin to learn the principles of simple coding;
- meet some of the basic ideas of how a computer program can control the movements of a machine;
- develop mathematical thinking about the order of the steps to draw a simple diagram and about the angles and lengths to use.

Generic competences

In doing this activity students will have an opportunity to learn to write simple code for a computer and to develop awareness of some of the ways computers control machines.

Suggestions for teaching

This lesson builds on learners' life experiences of looking in mirrors and moving around and turning corners.

In a preceding lesson a day or two before have a short discussion about what learners see when they look at themselves in a mirror. Ask them to look in a mirror before the next lesson and to note what happens when they raise a hand, touch one ear or wink one eye.

If learners have met the concepts before, then start with the Diagnostic Quiz to review the concepts of rotation and reflection. If not, this Quiz can be done at the end of the lesson, and the People Maths activities can be used to familiarise the learners with the mathematical language for turns and images in mirrors. They already have experience of this anyway.

For this lesson, ideally have the learners in a space outdoors, in a wide corridor or in a room such as the school hall. Ask them about what they know about robots. Let them talk a bit about drones and driver-less cars, about robots that move around warehouses to pick up and carry loads from place to place, about robots that mow lawns and clean floors, about robots that control complicated machinery in manufacturing processes etc.

Then say that in this lesson they are going to command robots but to start with they have to pretend to be robots themselves.

Ask them questions about **reflection** and then tell them to work with a partner and face each other. Tell them that they must take it in turns to be the robot and the one who commands it. One of them should make 3 different actions and the partner must robotically copy the action as if he or she is the image in a mirror. Then they swop roles, the partner must do 3 different actions and the first learner must copy them like an image in a mirror.

Then ask a few questions about reflections before moving on to **rotation.**

Explain the commands RIGHT 360 and LEFT 360 and give these commands a few times so that the learners follow the commands like robots. Then explain the commands RIGHT 180 and LEFT 180 and practice all 4 commands until the learners seem to know the difference between full turns and half turns and between left turns and right turns. Then explain the commands RIGHT 90 and LEFT 90 and practice all six commands with the learners acting as robots. You can ask the learners in turn to give commands to the rest of the class.

You have the choice of introducing the words clockwise and anti-clockwise, or not. You also have the choice of introducing the idea of measuring angles in degrees, or just talking about quarter turns, half turns and full turns.

You could simply use the numbers 360^o, 180^o and 90^o to label full turns, half turns and quarter turns. It does not matter if the learners have not met degree measure before – this will prepare them for a later lesson on measuring angles.

Then move on to **translations.**

Explain the commands FORWARD 7 and BACK 2 (7 for 7 steps and 2 for 2 steps) and ask the learners what they think these commands mean. Then give these commands and similar commands varying the number of steps, and all the class should do exactly the same moves.

Then give these commands slowly, one command at a time, and the learners must obey.

FORWARD 3, RIGHT 90, FORWARD 7, RIGHT 90,

FORWARD 3, RIGHT 90, FORWARD 7, RIGHT 90

Did everyone walk around a rectangle and end up at the same point they started at and facing the same direction?

Practise sets of commands making the learners go forward and back and turn right and left. You could put one of the learners in charge of the robots and that learner could give the commands.

Then return to the classroom. Either print all or part of the worksheet on pages 1 and 2 to give out to the learners, or write the problem on the board and tell the learners to do the work on squared paper.

The learners could work individually or in pairs. You can round off this lesson with different learners drawing on the board the paths that they have created for their robots and describing the journeys. You can then summarise what they have learned about reflections, rotations and translations and about giving commands to control a robot.

More **practice** and **repetition** of the coding language is the best way to become confident about coding.

You can include this for a few minutes a day in each lesson for the next few lessons and then again when you want to review the ideas and the mathematical language. Even if there is no space for everyone to walk forward and back you can be the object and they can reflect your actions like images in a mirror. To practice rotations everyone can stand and turn on the spot. For translations one learner can be the robot and other learners can give the commands such as for him to walk from the door to his place in class.

Key questions

- If you look at yourself in a mirror and touch your right ear what does your image do?
- If you look at yourself in a mirror and wink your left eye what does your image do?
- If you look at yourself in a mirror and step back what does your image do?
- If you look at yourself in a mirror and step to your right what does your image do?
- If you look at yourself in a mirror and turn to your right what does your image do?
- Imagine yourself walking around a square, what would you do?
- Would you turn right or left at that corner?
- Is that a quarter turn or a half turn?
- How many half turns do you have to make before you get back to face the same direction as at the start?
- How many quarter turns do you have to make before you get back to face the same direction as at the start?

Follow up

Learners could learn to write programs in logo starting with **Command the Robot 2**
https://aiminghigh.aimssec.ac.za/years-4-9-command-the-robot-2/

First Forward Into Logo https://nrich.maths.org/8045
This is the first in a twelve part series of articles introducing Logo programming for beginners. Even if you have never tried LOGO it is easy to learn and First Forward is the place to get started!

The programs were written using MSWLogo and you can download this excellent free software from the internet. You can download free Logo software,
either FMSLogo for Microsoft Windows from http://fmslogo.sourceforge.net/
or ACSLogo for Mac OS X from http://www.alancsmith.co.uk/logo/
Both come with a Tutorial to help you to get started.