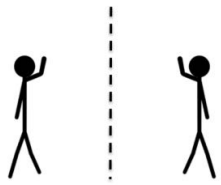
AIMSSEC

AFRICAN INSTITUTE FOR MATHEMATICAL SCIENCES
SCHOOLS ENRICHMENT CENTRE
TEACHER NETWORK

COMMANDING 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, about robots that mow lawns and clean floors and about robots that control complicated machinery in factories?



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.

WHOLE CLASS ACTIVITY

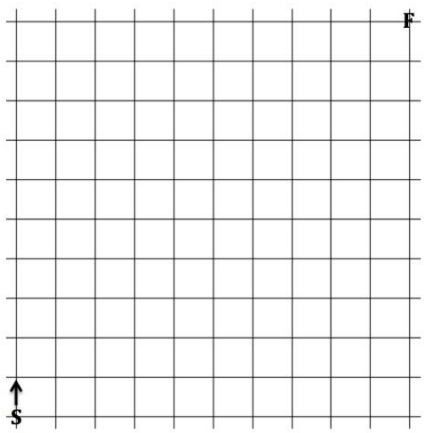
You will learn something about how people write codes to program computers to control robots. To start with you have to pretend to be a robot yourself and you must follow commands.

The class will need to be in a space outdoors, in a wide corridor or in a big room such as the school hall. Your teacher 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^o 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^o 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^o to your right (clockwise).
LEFT 90 tells you to TURN through a QUARTER TURN 90^o to your left (anti-clockwise).

TRANSLATIONS



FORWARD 7 and BACK 2 tells you to take 7 steps forward and 2 steps back.
RIGHT 90 FORWARD 5 LEFT 90 tells you to make a quarter turn clockwise, to take 5 steps forward then to make a quarter turn anticlockwise so you face the same way as at the start.

Now 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. Write a list of commands to make your robot go from S to F in exactly 30 steps. Draw his path on a copy of this grid and describe his journey.

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 in 30 steps. This is one:

FORWARD 10 RIGHT 90
FORWARD 5 RIGHT 90
FORWARD 5 LEFT 90
FORWARD 5 LEFT 90
FORWARD 5

NOTES FOR TEACHERS

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' pretending to act as a robot 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.

Intended learning outcomes

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

Suggestions for teaching

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

In the lesson preceding this one have a class 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.

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 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 not.

You could simply use the numbers 360, 180 and 90 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.

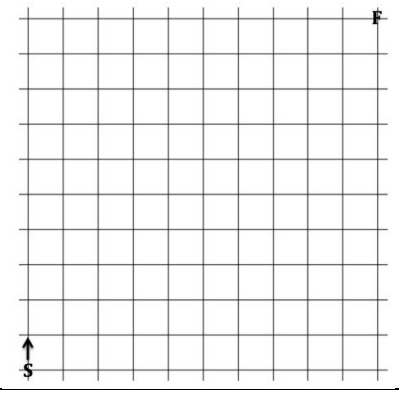
Then move on to **translations.**

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 and either give the learners this worksheet or write the problem on the board. The learners could work individually or in pairs.



COMMAND THE ROBOT

Now 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. Write a list of commands to make your robot go from S to F in exactly 30 steps.

Draw his path on a copy of this grid and describe his journey.

You can round off this lesson with different learners drawing the paths on the board 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.

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?

Possible extension

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

Possible support

More **practice** and **repetition** of the mathematical language is the best way to support learners in this work.

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.

Note: The Grades or School Years specified on the AIMING HIGH Website correspond to Grades 4 to 12 in South Africa and the USA and to Years 4 to 12 in the UK.				
	Lower Primary or Foundation Phase	Upper Primary	Lower Secondary	Upper Secondary
South Africa	Grades R and 1 to 3	Grades 4 to 6	Grades 7 to 9	Grades 10 to 12
USA	Kindergarten and G1 to 3	Grades 4 to 6	Grades 7 to 9	Grades 10 to 12
UK	Reception and Years 1 to 3	Years 4 to 6	Years 7 to 9	Years 10 to 13
East Africa	Nursery and Primary 1 to 3	Primary 4 to 6	Secondary 1 to 3	Secondary 4 to 6