AIMSSEC

AFRICAN INSTITUTE FOR MATHEMATICAL SCIENCES
SCHOOLS ENRICHMENT CENTRE (AIMSSEC)
AIMING HIGH

This INCLUSION AND HOME LEARNING GUIDE
suggests related learning activities for all ages from 4 to 18
on the theme of CODING

Choose what seems suitable for the age or attainment level of your learners

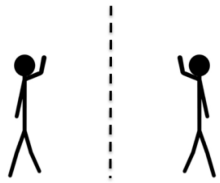
The COMMAND THE ROBOT 1 activity was designed for Primary and Lower Secondary

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?

Touch your right ear, what does your mirror image do? Try it.

Wink with your left eye. Does your image seem to wink with his left eye or his right eye? Try it?

Try other actions. Describe what you did and what your image did.

REFLECTIONS

Work with a partner and face each other. Touch your nose with your right hand.

Your partner must do the action of a mirror image, but which hand should he use?

Make 3 different actions. Your partner must copy you as if he or she is your image in a mirror. The image is called **a reflection**.

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

GROUP ACTIVITY

You will learn something about how people write codes to program computers so that they control robots. To start with you must 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. You don't need to know anything about programming in any language, all the commands are given and explained below.

The group will need to be spaced out, so depending on the size of the group or class, it may need to be outdoors, in a wide corridor or in a big room such as the school hall.

Your 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: TURN through a **FULL turn 360º clockwise (to your right**) and you will end up facing the direction you faced at the start.

LEFT 360 tells you: TURN through a **FULL turn 360º anti-clockwise (to your left)** and end up facing the direction you faced at the start.

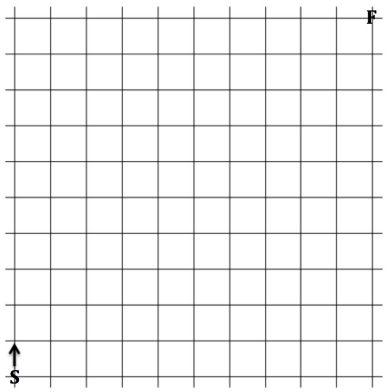
RIGHT 180 tells you: TURN through a **HALF turn 180º clockwise (to your right)** and end up with your back to the direction you faced at the start.

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

RIGHT 90 tells you: TURN through a **QUARTER TURN 90º to your right (clockwise).**

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

TRANSLATIONS



These are translations:

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

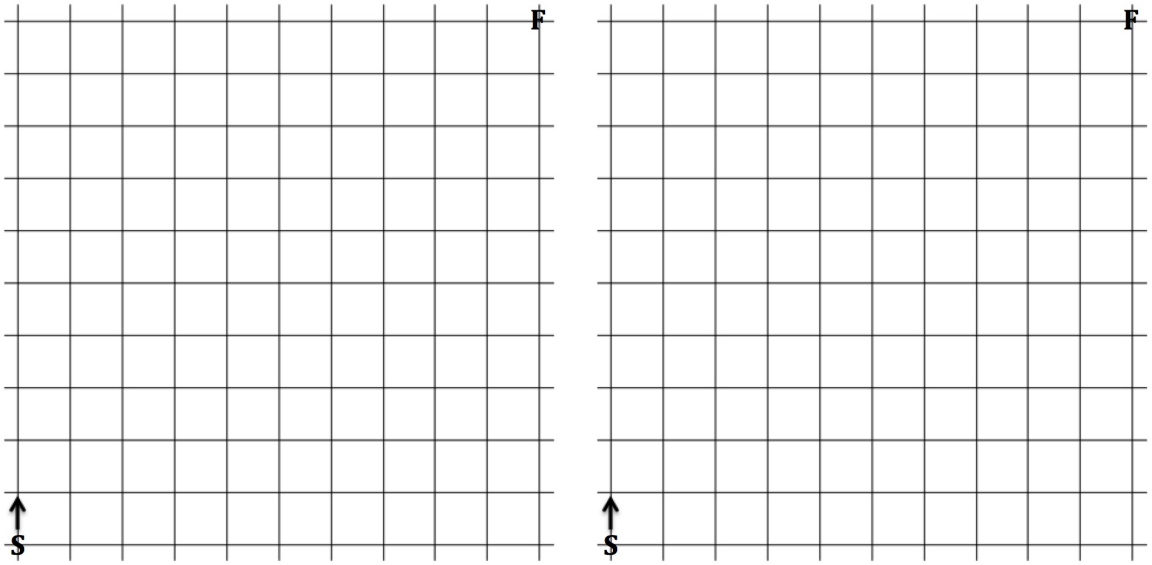
RIGHT 90 FORWARD 5 LEFT 90 tells you:
make a quarter turn clockwise,
take 5 steps forward
then make a quarter turn anticlockwise
so you face the same way as at the start.

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. Then write a list of commands to make your robot follow the path and 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,

INCLUSION AND HOME LEARNING GUIDE

THEME: CODING

Early Years

People Maths: *by doing actions and talking about what they are doing, the children start to learn about reflections and the difference between right and left. They will follow unspoken commands by copying actions pretending to be a reflection in a mirror.*

Explore reflections in a mirror with the children. Play a game where one of you does an action and the other one pretends to be the reflection in a mirror. Start by looking at hands and talking about them. Through talk and games try to build up understanding of the words: reflection, image, mirror, right hand, left hand.

Say to the children: Look at your hands.

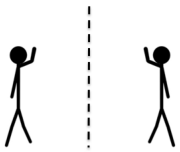
What is the same and what is different about them?

Which is your right hand? Which is your left hand?

This picture shows one hand and its image in a mirror.

What do you notice? Try it with one of your hands and a mirror.

What happens when you look in a mirror?



If you touch your right ear what does your mirror image do? Try it.

Wink with your left eye.

Does your image wink with his left eye or his right eye? Try it?

Try some other actions. What did you do? What did your reflection do?

Play a game in pairs.

One person has to act like the image of the other person.

The image just follows whatever actions the other person does.

If you have a group, one person faces everyone else and gives commands by doing actions of different sorts.

Everyone else copies the actions pretending to be reflections or images in a mirror.

Lower Primary

People Maths: *by doing actions, and talking about what they are doing, the children learn about reflections and rotations and the difference between right and left. They start to learn about robots and about giving commands to tell a robot what to do. This will lead, when they are older, to coding (writing computer programs).*

Explore ideas of **reflection** and **mirror images** as with the Early Years group and also the idea of rotating or turning.

Through talk and games try to build up understanding of the words: reflection, image, mirror, right hand, left hand and also full turn, half turn and quarter turn.

Talk about **robots that follow commands**. Tell the children that they are going to pretend to be robots and you are going to give commands, and after a while one of them can give commands instead of you. Tell them they will be like soldiers on a parade ground.

You need space for this activity so that the children can move as 'commanded' so do it outdoors or in a hall or big room.

Introduce the commands in the list below one by one and practice them.

- **Be my reflection**
- **Right full turn.**
- **Right half turn.**
- **Right quarter turn.**
- **Left full turn.**
- **Left half turn.**
- **Left quarter turn.**
- **Forward 1 step. Forward 2 steps etc.**
- **Back 1 step. Back 2 steps etc**.

Try sequences of commands like:

1. **Forward 3 steps.**
2. **Right quarter turn.**
3. **Forward 4 steps**
4. **Right quarter turn**
5. **Forward 3 steps.**
6. **Right a quarter turn.**
7. **Forward 4 steps**
8. **Right a quarter turn**

What happens?
What shape did they walk around?
How much did they turn altogether?
Which way were they facing at the start?
Which way were they facing at the end?
Give the same commands but with Left quarter turns instead of right. What happens?

Upper Primary

People Maths: *by doing actions, and talking about what they are doing, the learners will explore ideas about reflections and rotations and the difference between right and left. They will start to learn about robots and about giving commands to tell a robot what to do. This will lead, when they are older, to coding (writing computer programs)*

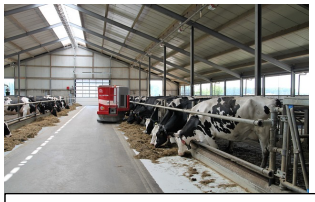
PEANUT BUTTER AND JELLY SANDWICH The theme here is coding.

The challenge for you is to write the instructions
to make a Peanut Butter and Jelly sandwich.

Everyone will follow your instructions TO THE LETTER.

Watch the video to see what can happen if your instructions are not precise.

https://youtu.be/Ct-lOOUqmyY



Milking robot

Mars Explorer

Crop sprayer

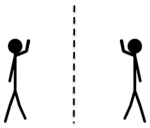
Lawn mower

Ask questions 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? Can robots control complicated machinery in factories? What do you think about robots that mow lawns and clean floors?

Talk about **robots that follow commands**. Tell the learners that they are going to pretend to be robots and you are going to give commands, and after a while one of them can give commands instead of you.

You need space for this activity so that the learners can move as 'commanded' so do it outdoors or in a hall or big room.

REFLECTIONS



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Wink with your left eye.

Does your image 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.

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.

Touch your nose with your right hand. Your partner must do the action of a mirror image, but which hand does he use to touch his nose?

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

GROUP ACTIVITY

You don't need to know anything about programming in Logo or in any other language, all the commands are given and explained. The group can of any size.

Tell the learners that they will learn something about how to write codes to program computers so that they control robots. Tell them that they have to pretend to be a robot and follow commands. The commands are in the Logo language, which is one of many programming languages, but they are usually abbreviated in the code.

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

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

ROTATIONS

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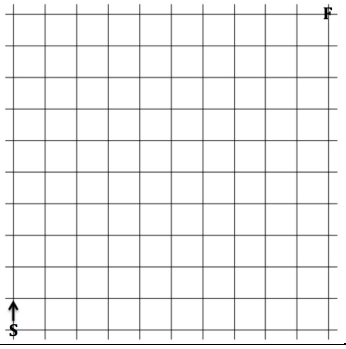
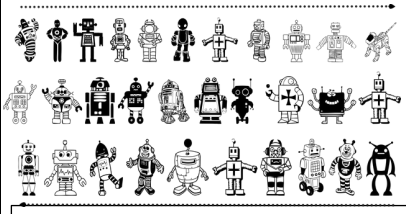


After the People Maths activity, the learners will sit down with a grid like this and draw a route going along the grid lines from S to F.

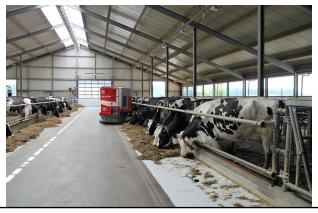
Then they must write down the instructions to **command a robot** to follow the route and end up facing in the same direction as at the start.

Lower Secondary

People Maths: *by doing actions, and talking about what they are doing, the learners will explore ideas about reflections and rotations and the difference between right and left. They will start to learn about robots and about giving commands to tell a robot what to do. This will lead, when they are older, to coding (writing computer programs)*



Robots



Milking robot

Mars Explorer

Crop sprayer

Ask questions about robots. What are drones? Are driver-less cars actually robots? What is Artificial Intelligence? Can robots control complicated machinery in factories? Can robots move in warehouses to select, pick up and carry loads from place to place? What do you think about robots that mow lawns and clean floors?

Talk about **robots that follow commands**. Tell the learners that they are going to pretend to be robots and you are going to give commands, and after a while one of them can give commands instead of you.

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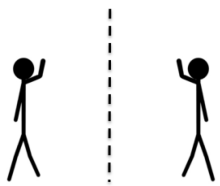

REFLECTIONS

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

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robot and follow commands. The commands are in the Logo language which is one of many programming languages, but they are usually abbreviated in the code.

The group will need space, either a in big room or outdoors.

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

ROTATIONS

RIGHT 360 tells you to TURN through a FULL turn 360° clockwise (to your right) and to end up facing the direction you faced at the start.

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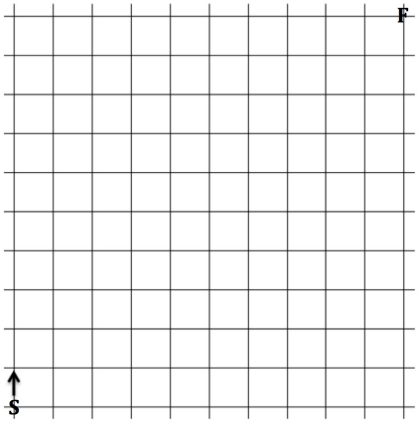


After the People Maths activity, the learners will sit down with a grid like this and draw a route going along the grid lines from S to F.

Then they must write down the instructions to **command a robot** to follow the route and end up facing in the same direction as at the start.

SUGGESTIONS FOR HOME LEARNING *You will need a mirror*

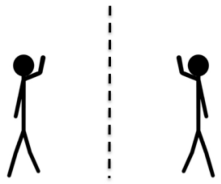
This lesson builds on learners' life experiences of looking in mirrors, moving around and turning corners. It helps them to develop an understanding of TRANSFORMATIONS (reflections, rotations and translations) and introduces the basics of computer programming.

Start with a short discussion about what learners see when they look at themselves in a mirror. Ask them to look in a mirror 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. Anyway they already have life experience of this.

Ideally have the group in a space outdoors or a big room so they can be spaced out. 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 industrial processes etc. (See page 8.)

Then say that in this lesson they are going to command robots and to start with **the learners 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, one to be the robot and the other to command the robot. 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 to review reflections before moving on to **rotation.**

Explain the commands RIGHT 360 and LEFT 360 and that the commands give the angle of turning in degrees. 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.

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 learners 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.

Then put one of the learners in charge to give the commands to the robots.
Do some more of the People Maths with one commander and a group of robots.

Then sit down to start coding. The learners could work individually or in pairs.

COMMAND THE ROBOT

LOGO COMMANDS

FORWARD 7 tells you to take 7 steps forward.

BACK 2 tells you to take 2 steps back.

RIGHT 360 tells you to TURN through a FULL 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 FULL 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.

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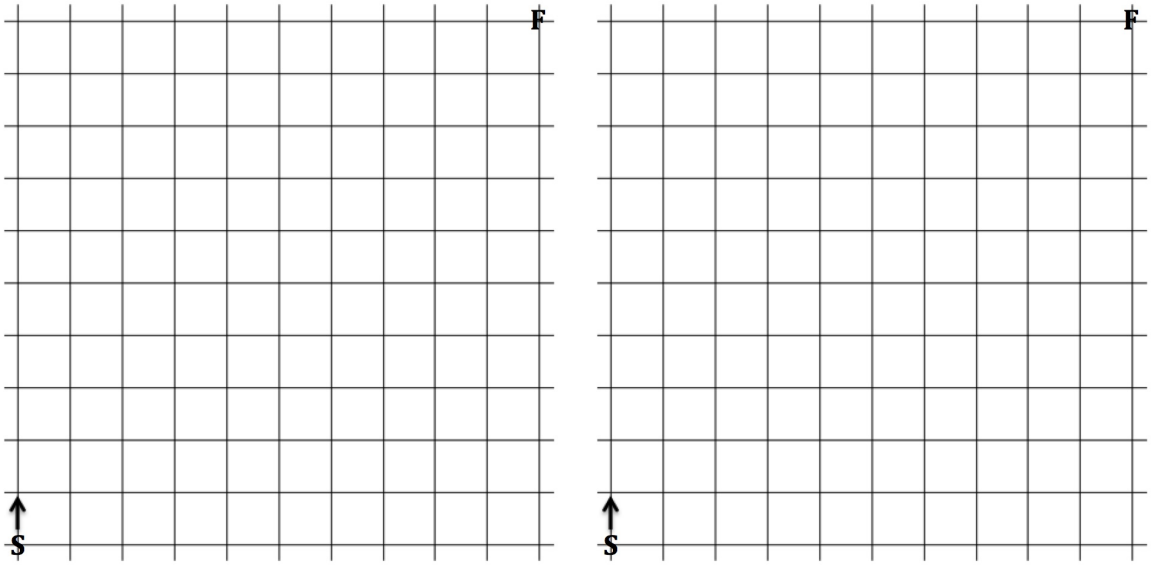
RIGHT 90 tells you to TURN through a QUARTER TURN 90^{o} to your right (clockwise).

LEFT 90 tells you to TURN through a QUARTER TURN 90^{o} to the left (anti-clockwise)

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 the grid below 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 do the journey exactly as you described it.

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.



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.

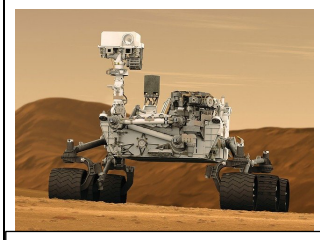
The best way to become confident about coding is to **practise by writing codes** in the coding language to carry out different tasks. You can include these activities for a few minutes on other occasions to review the ideas and the mathematical language. Even if there is no space for everyone to walk 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 some other point in the room.

Key questions

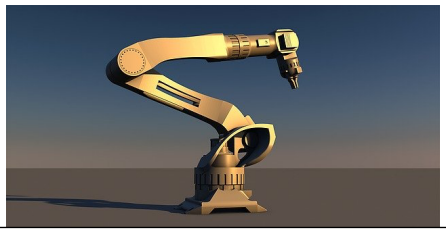
- If you look at yourself in a mirror and step back what does your image do?
- If you look at yourself in a mirror and step to your right what does your image do?
- If you look at yourself in a mirror and turn to your right what does your image do?
- If you look in a mirror and touch your right ear what does your image do?
- If you look in a mirror and wink your left eye 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?

Upper secondary

COMMAND THE ROBOT 1



Mars Rover Explorer



Artificial arm

Car assembly line

What do you know about robots? What can they do? What can't they do?

What is Artificial Intelligence (AI)?

What are drones? Are driver-less cars actually robots?

How do robots move about in warehouses, select the right objects, pick them up and carry the components needed for an assembly line or sales order to the right place?

What about robots that control complicated machinery in factories?

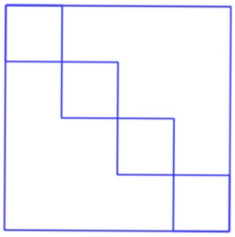
What do you think about robots that mow lawns and clean floors?

Robots are controlled by computers, both remotely and built-in. Commands are written in computer programs or code. There are many different computer languages.

START WRITING YOUR OWN CODES. Use the Logo commands on pages 11 & 12. Do the task there to practice writing a computer program in the Logo language.

Logo is the name of a family of languages, rather than one single standard language. You can't expect programs written for one Logo to run unchanged in another version.

Logo was created in 1967 at Bolt, Beranek and Newman (BBN), a Cambridge, Massachusetts research firm, by Wally Feurzeig, Cynthia Solomon, and Seymour Papert. Its intellectual roots are in artificial intelligence, mathematical logic and developmental psychology. Seymour Papert developed ideas for using Logo in schools, including floor turtles controlled by Logo commands for children as young as 3 or 4 years old.



You don't need to know anything about programming at the start; you will learn enough at the first stage to write your own programs, and you may surprise yourself by how much you can achieve right away.

Using the commands on page 11, can you write the code to draw this pattern?

There are plenty of free web resources to get you started.

Windows users can download a free copy of FMSlogo.

A good free version for Mac users is ACSlogo.

For a version you can run in your browser go to http://calormen.com/logo/.

Later you can move on to languages that are used in the commercial world, for example Processing (java) or Nodebox (python) for graphics, or Eloquent Javascript text as an introduction to web programming.

For general purpose mathematical programming, try python or ruby.

SOLUTION *to task on page 11*

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

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

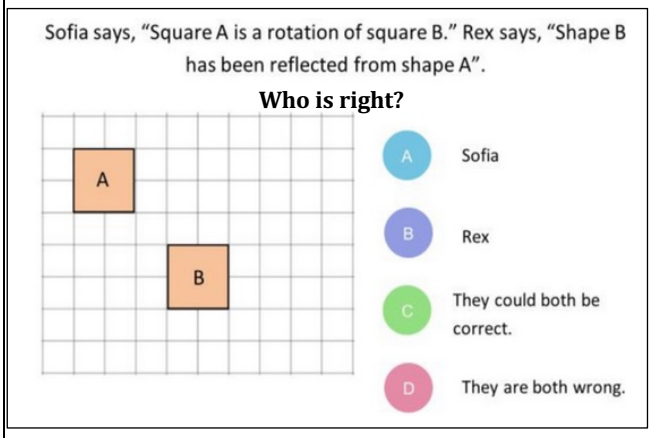
In doing this activity students will have an opportunity to:

- 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 that computers control machines.

DIAGNOSTIC ASSESSMENT This can be used before or after the lesson.



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

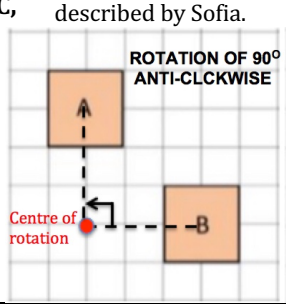
1.Notice how the learners respond. Ask them to explain why they gave their answer and DO NOT say whether it is right or wrong, simply thank the learner for the answer.
2.It is important for learners to explain the reason for their answer so that, by putting their thinking into words, they develop communication skills and get a better understanding.
3.For a group, make sure that other learners listen to these reasons and try to decide if their own answer was right or wrong.

5. Ask the learners to vote for the right answer by putting up 1, 2, 3 or 4 fingers. Look for a change and who gave right and wrong answers.

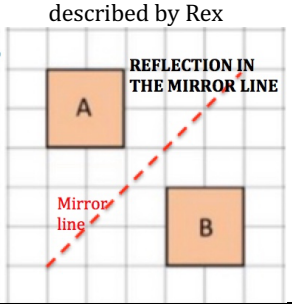
https://diagnosticquestions.com

The correct answer is C, they are both correct.

Transformation as described by Sofia.



Transformation as described by Rex



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. 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.

Go to the **AIMSSEC AIMING HIGH** website for lesson ideas, solutions and curriculum links: http://aiminghigh.aimssec.ac.za

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