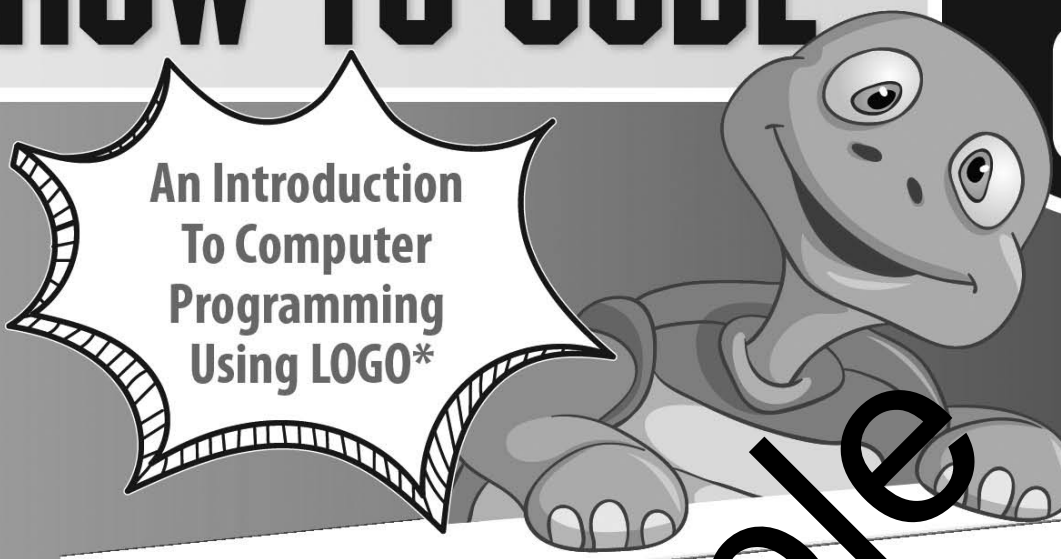
LEARNING HOW TO CODE

PHOTOCOPY MASTERS

Years 4-6

Ready-Ed Publications

An Introduction To Computer Programming Using LOGO*



CURRICULUM LINKED

By Phillip Richards

*LOGO is a free downloadable computer program Details on page 8

Contents

Teachers' Notes

What Is LOGO?

LOGO is a free downloadable computer program that allows students to explore geometrical concepts by typing in commands that move a turtle around a screen. As the turtle moves, it draws lines. By using simple commands, students plan and create geometrical figures and designs.

Why Use LOGO?

Using LOGO requires problem solving with logical deductions and creative and critical thinking. Students will learn about 2D shapes and angles while using this program. They will be motivated to use Geometry because of the challenging nature of the program and its 'fun' properties. Students will learn a computer language and will understand that it is important to 'have a go'. Being wrong will lead them closer to the desired outcome and trial and error (experimenting and correcting) will lead to a planned and conceptualised result. As students correct 'bugs', they will move nearer to finding a solution.

Who Is LOGO For?

- Primary and secondary students – it caters for all year levels
- IT/STEM students
- Gifted and talented students
- Design and Technologies students
- Classroom teachers wanting an anchoring activity to help cater for fast finishers working with a compacted curriculum
- Classroom teachers searching for inexpensive ways to develop schemes of differentiation in the classroom

LOGO Pros

- LOGO is an exceptional tool to practise Geometry
- LOGO has a low threshold but has a virtually unreachable ceiling
- LOGO fits the curriculum for Geometry and Measurement: 2D shapes – polygons, angles, tessellations, symmetry and transformations, co-ordinates
- LOGO has built-in **student differentiation** – students can progress as far and as fast as they like
- LOGO develops and strengthens planning skills
- Students are keen to attend LOGO sessions
- Print-outs of patterns and designs give tangible proof of outcomes
- Teachers are easily able to create challenges and problems
- LOGO involves learning how computer languages work
- There is extensive academic backing for LOGO's use
- LOGO demands creativity coupled with being precise and accurate
- LOGO encourages students to invent and discover
- Teachers do not have to be 'experts' to introduce and follow this course – if you find your students are flying beyond you; that is all good!

Options

The worksheets in this book can be completed individually or in pairs. Students who finish the set work early should be encouraged to explore other shapes and patterns on their own.

It can be useful to have students use an exercise book with a grid pattern. They may like to sketch out what they want to do and to plan a program. It may also be valuable to have them write down their commands.

Printing A Design

Printing directly from LOGO is not recommended. Usually there will be a lot of white space around the design; cropping will make the picture more practical to print. Follow these steps to print a design:

1. Save the design as a bmp, go to ***Menu Bar > Bitmap > Save As***
2. Open up the bitmap in a photo editing software program, e.g. Paint or Photoshop, crop the design, then save.
3. Print directly from the picture editing program or import the bitmap into a word document or software of choice, then print.

Curriculum Links

LOGO sits neatly within the Australian Curriculum as it links to Mathematics and Digital Technologies. The Geometry and Measurement strands in the Mathematics learning area are particularly relevant as they involve shapes, angles, transformations and measurement.

Year 4

MATHEMATICS

Compare and describe two dimensional shapes that result from combining and splitting common shapes, with and without the use of digital technologies (ACMMG088)

Compare the areas of regular and irregular shapes by informal means (ACMMG087)

Construct suitable data displays, with and without the use of digital technologies, from given or collected data (ACMSP096)

Generating ideas, possibilities and actions creating a two-dimensional shapes from verbal or written instructions. Create symmetrical patterns, pictures and shapes with and without digital technologies (ACMMG09

Compare angles and classify them as equal to, greater than, or less than, a right angle (ACMMG089)

SCIENCE

Science involves making predictions and describing patterns and relationships (ACSHE061)

Compare results with predictions, suggesting possible reasons for findings (ACSIS216)

TECHNOLOGY

Sequence steps for making designed solutions and working collaboratively (ACTDEP009)

Define simple problems, and describe and follow a sequence of steps and decisions (algorithms) needed to solve them (ACTDIP010)

Implement simple digital solutions as visual programs with algorithms involving branching (decisions) and user input (ACTDIP011)

Evaluate design ideas, processes and solutions based on criteria for success developed with guidance and including care for the environment (ACTDEP017)

Plan a sequence of production steps when making designed solutions individually and collaboratively (ACTDEP018)

"A natural choice for a programming language to use in geometry activities is LOGO".
Michael T. Battista (Professor of Mathematics Education)

Year 5

Connect three-dimensional objects with their nets and other two-dimensional representations (ACMMG111)

Estimate, measure and compare angles using degrees. Construct angles using a protractor (ACMMG112)

Use efficient mental and written strategies and apply appropriate digital technologies to solve problems (ACMNA291)

Apply the enlargement transformation to familiar two dimensional shapes and explore the properties of the resulting image compared with the original (ACMMG115)

Estimate, measure and compare angles using degrees (ACMMG112)

SCIENCE

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena (ACSHE081)

TECHNOLOGY

Develop project plans that include consideration of resources when making designed solutions individually and collaboratively (ACTDEP028)

Design, modify and follow simple algorithms involving sequences of steps, branching, and iteration (repetition) (ACTDIP019)

Year 6

MATHEMATICS

Select and apply efficient mental and written strategies and appropriate digital technologies to solve problems involving all four operations with whole numbers (ACMNA123)

Construct simple prisms and pyramids (ACMMG140)

Investigate combinations of translations, reflections and rotations, with and without the use of digital technologies (ACMMG142)

Introduce the Cartesian coordinate system using all four quadrants (ACMMG143)

Investigate, with and without digital technologies, angles on a straight line, angles at a point and vertically opposite angles. Use results to find unknown angles (ACMMG141)

Describe probabilities using fractions, decimals and percentages (ACMSP144)

SCIENCE

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena (ACSHE098)

DESIGN & TECHNOLOGY

Develop project plans that include consideration of resources when making designed solutions individually and collaboratively (ACTDEP028)

Design, modify and follow simple algorithms involving sequences of steps, branching, and iteration (repetition) (ACTDIP019)

ACTIVITY

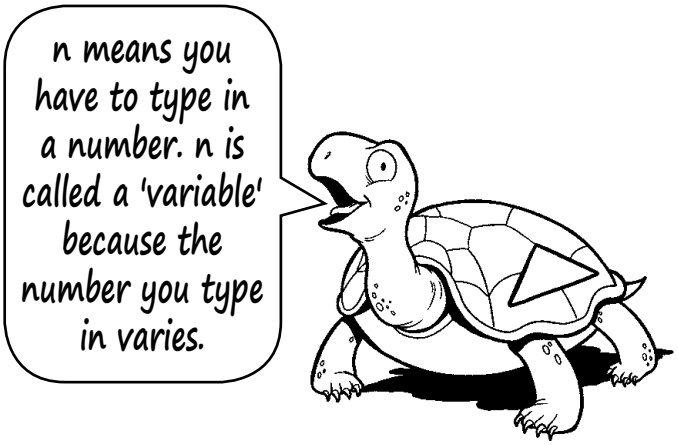
Introducing The Turtle 1

The table below shows some basic commands and shortcuts for the computer program LOGO. n means a number has to go after the instruction. A number can represent steps or degrees! If you tell the turtle to ***fd 50***, you are telling the turtle to move forwards 50 steps. If you tell the turtle to ***rt 90***, you are telling the turtle to right turn 90 degrees.

1. Type each instruction into COMMANDER INPUT. Tick each one once you have mastered each shortcut. You may need to use clearscreen *(cs)* before each attempt.

Instruction	Shortcut	What it does	Tick
showturtle	***st***	Shows the turtle.	
hideturtle	***ht***	Hides the turtle.	
forward n	***fd n***	Moves the turtle forward BUT you have to tell it how far. E.g. ***fd 50***.	
back n	***bk n***	Moves the turtle backwards BUT you have to tell it how far. E.g. ***bk 50***	
right n	***rt n***	Turns the turtle to the right or clockwise. You need to tell it how far to turn in degrees. E.g. ***rt 90***.	
left n	***lt n***	Turns the turtle left or anti-clockwise. You will need to tell it how far in degrees. E.g. ***lt 90***.	
home	***h***	The turtle goes straight home. Useful if it gets lost off screen.	
clearscreen	***cs***	Wipes the world clean and puts the turtle back home.	
clean	***clean***	Rubs out all the lines but leaves the turtle where it is.	

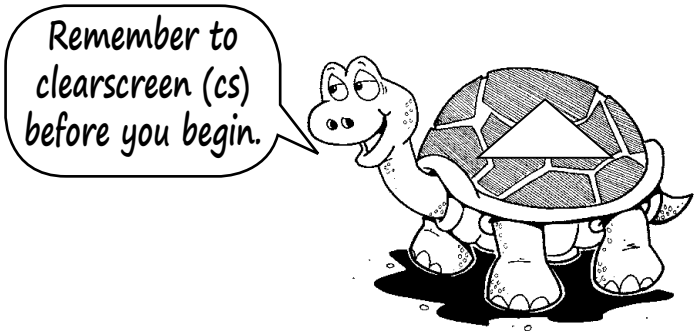
2. Challenge! Can you work out how to draw a square using some of the commands above? Write down the command you gave the turtle below.



ACTIVITY 2

Sticks, Dashes & Stairs

Sticks, dashes and stairs are line patterns that you can make by instructing the turtle to lift off the page, so that it does not leave a mark. You can make the lines thicker or thinner by adjusting the pen size.



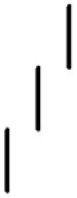
Instruction	Shortcut	What it does
penup	***pu***	This lifts the turtle up so it does not leave a mark.
pendown	***pd***	This puts the turtle down again.
setpensize n n = number		This makes the pen thicker or thinner. Try ***setpensize 5*** or click on ***se*** from THE MENU BAR and select ***pensize*** to adjust.

❑ Can you create these four patterns on screen? Follow the instructions for Shapes A, B and C. Don't forget to ***clearscreen (cs)*** after each one. Write the instructions in the space provided that you used to create shapes.

Shape A (dashes)

setpensize [5 5]
fd 40 pu fd 20 pd
fd 40 pu fd 20 pd
fd 40 pu fd 20 pd

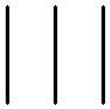
Shape B (stairs)



setpensize [2 2]
fd 80 pu rt 90 fd 40 lt 90 pd
fd 80 pu rt 90 fd 40 lt 90 pd
fd 80 pu rt 90 fd 40 lt 90 pd

Shape C : (sticks)

setpensize [1 1]
pd fd 80 bk 80 pu rt 90 fd 40 lt 90
pd fd 80 bk 80 pu rt 90 fd 40 lt 90
pd fd 80 bk 80 pu rt 90 fd 40 lt 90

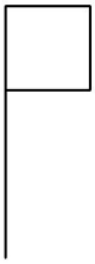


Shape D (bold stairs)

ACTIVITY 6

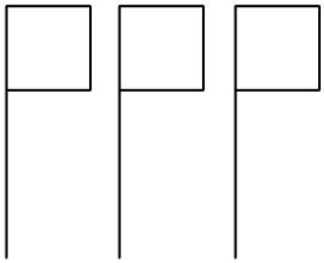
Flags 1

1. Teach the turtle to make a flag. Your turtle should already know how to draw a square. It will need to know how to square to draw the flag.



So try: ***to flag***, then press ***Enter***. Type in ***fd 100 square bk 100***, then click ***end***. Remember to type in: ***flag*** to test the turtle's memory.

2. How do you create more than one flag? Type in the instructions below.



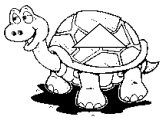
Type in ***to threeflags***, then press ***Enter.***

Type in: ***repeat 3 [flag rt 90 pu fd 150 lt 90 pd]***

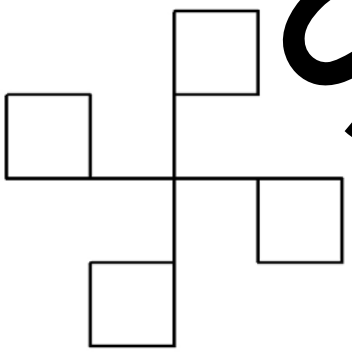
then press ***end***. Now type in: ***threeflags*** and they should appear!

Remember!

pu means ***pen up*** and ***pd*** means ***pen down***.

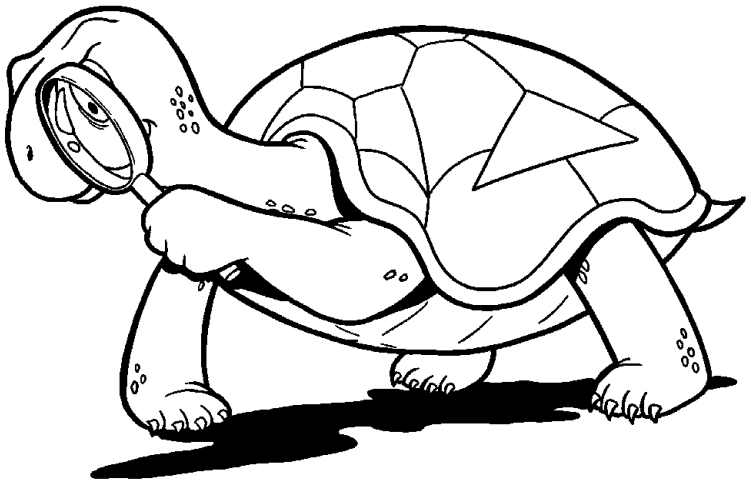


3. Can you create a spinning flag using the repeat instruction? Type in the instructions below.



Firstly draw one flag, by typing in: ***flag***. To teach it to spin this flag, type in: ***to spinflag*** and press ***Enter***. Type in: ***repeat 4 [flag rt 90]*** and press ***end***. Then type in: ***spinflag***.

If something doesn't work, remember to check COMMANDER OUTPUT and the EDITOR (EDALL) to look for bugs.

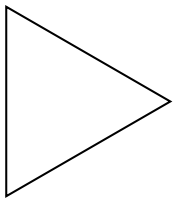


ACTIVITY 11

Colour 1

The pen colour can be set by using THE MENU BAR. You can adjust the shades of each colour by dragging the bars up and down.

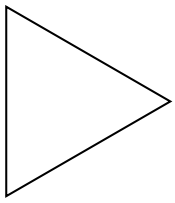
1. Can you create a yellow triangle? Follow the instructions below.



Go to ***set*** on THE MENU BAR and select ***pen colour***.
Click on ***yellow*** and press ***ok***. Now ask LOGO to ***triangle***.
Did you get a yellow triangle? _____

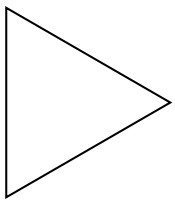
Alternatively, you can type in instructions to create colour. LOGO has 16 preset colours (1-15).				
	0 black	**4** red	**8** brown	**12** salmon
	1 blue	**5** magenta	**9** tan	**13** purple
	2 green	**6** yellow	**10** forest	**14** orange
	3 cyan	**7** white	**11** aqua	**15** grey

2. You will see from the list above that **4** represents red. Follow the instructions below to create a red triangle.



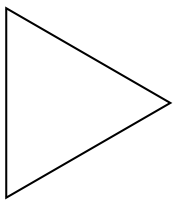
Type in: ***setpencolour 4*** or ***setpc 4*** Now ask LOGO to ***triangle***.
Did you get a red triangle? _____

3. Each preset colour has a value between 0 and 255. To manually adjust the shades of the colours type in a value. Follow the instructions below.



setpencolour [120 5 230] Type in: ***triangle.***
Did you get a purple triangle? _____
setpencolour [120 200 230] Type in: ***triangle.***
Did you get a light blue triangle? _____

4. Pen size or thickness can be set using two numbers.



setpensize [1 1] Type in: ***triangle.***
How thick/thin is the line? _____
setpensize [5 5] Type in: ***triangle.***
How thick/thin is the line? _____

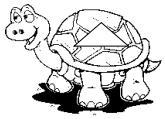
5. Can you create some other coloured designs? Work with a friend.

ACTIVITY 13

Randomness

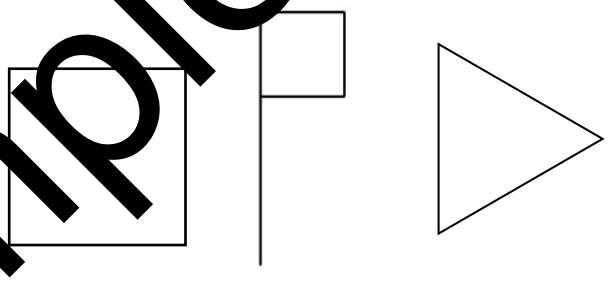
Random means anything could happen! We can ask the turtle to colour the shapes we create randomly. If we type in: ***setpencolour random 16***, the turtle will select, at random, a pencolour from the16 colours (0 -15). We do not know what the turtle will select. The turtle will select a different colour each time.

Remember!
For the exercise below to work, you must have taught LOGO how to **square** (Page 11), **flag** (Activity 6) and **triangle** (Activity 8).

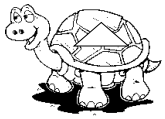


1. Create a square, flag and triangle using ***setpencolour random 16***. Write down the colours that LOGO creates underneath the shapes.

Type in: ***setpencolour random 16***
Type in: ***square***.
Type in: ***setpencolour random 16***
Type in: ***flag***
Type in: ***setpencolour random 16***
Type in: ***triangle***.



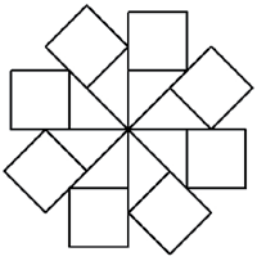
Remember!
The colours you produce will not be the same as the colours that your friend produces. This is because you are telling LOGO to select the colours at random.

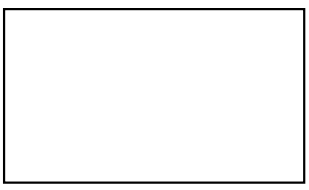


2. Now try these shapes. Write down the colours that LOGO creates underneath the shapes.

Type in: ***setpencolour random 16***
Type in: ***manyspinflags***.

Type in: ***setpencolour random 16***
Type in: ***rectangle***

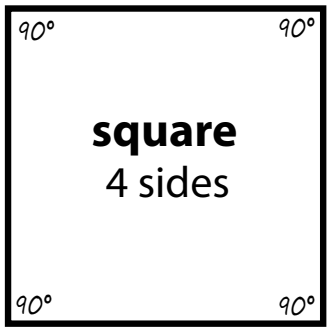


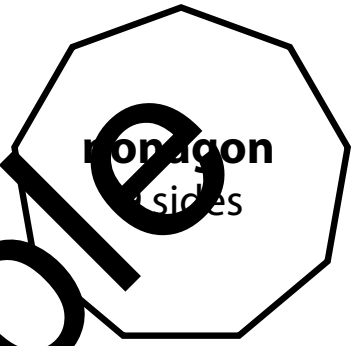


ACTIVITY 18

Polygons 1

A regular polygon is a polygon that is equiangular (all angles are equal in measure) and equilateral (all sides have the same length). Study the regular polygons below.





To create a square, the turtle turns 90 degrees four times or 90 x 4 = 360. This formula shows us that the angle that the turtle needs to turn is the number of sides of the polygon divided into 360 degrees. The turtle always makes a trip of 360 from the start to back. Use the formula **360/the number of sides** to make your polygon.

1. Applying the information above, calculate the angles that the turtle would have to turn to create a hexagon, octagon, and nonagon. Write the angles inside each shape above.
2. Create two octagons in LOGO. Follow the procedure below.

Type in: ***repeat 8 [fd 87 rt 45]*** then press ***Enter.***
Type in: ***repeat 8 [fd 40 rt 360/8]*** then press ***Enter.***
Which octagon is larger? Why?

_____

_____

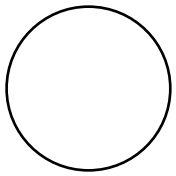
_____

_____

ACTIVITY 22

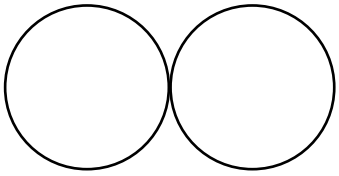
Circles & Arcs 1

1. **Circle!** Use any polygon procedure to draw a circle. You need 1 side and to turn 1 degree. Follow the example below.



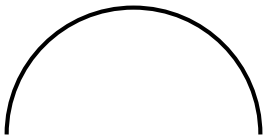
Type in: ***repeat 360 [fd 1 rt 1]*** then press ***Enter***.
What does ***fd*** stand for? _____
What does ***rt*** stand for? _____

2. **Two circles!** To make the circle go the other way and draw two circles next to one another, change the right turn ***(rt)*** to a left turn ***(lt)***.



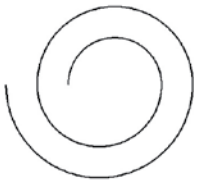
Type in: ***repeat 360 [fd 1 rt 1]*** then press ***Enter***.
Type in: ***repeat 360 [fd 1 lt 1]*** then press ***Enter***.

3. **Arc!** To make a semi-circle or an arc, you need to adjust how many turns it makes – e.g. reduce it by half to draw half the circle. Follow the example below.



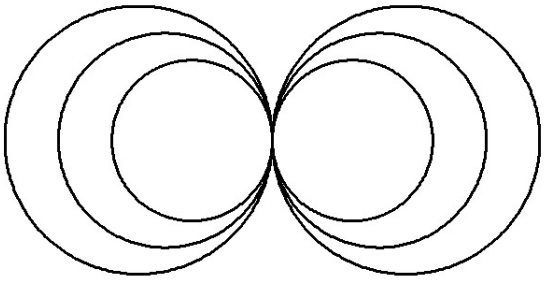
Type in: ***repeat 180 [fd 1 rt 1]*** then press ***Enter***.
What does 180 stand for?_____

4. **Spiral!** Gradually change the step size. Follow the example below.



Type in: ***repeat 180 [fd 1.5 rt 1] repeat 180 [fd 2 rt 1]***
repeat 180 [fd 2.5 rt 1] repeat 180 [fd 3 rt 1] then press ***Enter***.

5. **More circles!** To get the effect below, gradually increase the step size ***(fd)*** of a circle.



Type in: ***repeat 360 [fd 1.5 rt 1]***
Type in: ***repeat 360 [fd 1.5 lt 1]***
Type in: ***repeat 360 [fd 2 rt 1]***
Type in: ***repeat 360 [fd 2 lt 1]***
Type in: ***repeat 360 [fd 2.5 lt 1]***
Type in: ***repeat 360 [fd 2.5 rt 1]***
Then press ***Enter***.

6. **Experiment!** Create more patterns with circles, arcs and spirals. Print out your most interesting ones. Use the back of this sheet to keep a record of the procedures.