

The ScratchMaths curriculum

Freely available from the UCL website

<http://www.ucl.ac.uk/scratchmaths>

Year 5 – Computing focus (20+ hours of teaching materials)

**Module 1:
Tiling Patterns**



**Module 2:
Beetle Geometry**



**Module 3:
Collaborating Sprites**



Nano Tera
Pico Giga

Year 6 – Mathematics focus (20+ hours of teaching materials)

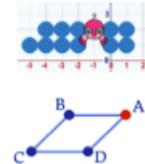
**Module 4:
Building with
Numbers**



**Module 5:
Exploring Mathematical
Relationships**



**Module 6:
Coordinates and
Geometry**



Extensive Teacher Support Materials and Example Scripts

MODULE 1: Tiling Patterns

Investigation 1
Moving, Turning and Stamping

Investigation 2
Repeating and Alternating Patterns

Investigation 3
Creating Circular Rose Patterns

Investigation 4
Defining Your Own Pattern Blocks

INTRODUCTION TO MODULE 1

The theme of Module 1 is **repeating patterns**. You may like to introduce this module by linking it to another area of the curriculum such as art or science where similar patterns can be found. Some examples are below:

ART: ISLAMIC OR GOTHIC ART
Geometric patterns have been used extensively in Islamic art for many centuries and can also be found in gothic architectural features, such as stained glass windows.

SCIENCE: PATTERNS IN NATURE
Geometric patterns are seen in nature for example in snowflakes or in the sand sculptures created by puffer fish on the ocean floor.

KEY VOCABULARY AND CONCEPTS COVERED BY MODULE 1

Scratch	Computer	Mathematics
<ul style="list-style-type: none"> Sprite Stage Block Stamp block Hot block Turn block Stamping blocks Sprite Mask block Repeat block Costume Define block 	<ul style="list-style-type: none"> Command Program, programming Debugging Sequence Repetition Logical reasoning Algorithm Definition 	<ul style="list-style-type: none"> Summary Angles (right, obtuse, reflex and acute) Reflection Rotation Translation Sequences Positive and negative numbers Coordinates

MODULE 1: INVESTIGATION 1 Moving, Turning and Stamping

OVERALL LEARNING OBJECTIVE: Drag, turn, move and stamp a sprite, and build a simple script to create a pattern without using unnecessary blocks.

This investigation introduces three important Scratch commands (**move**, **turn** and **stamp**) and gradually builds to using these in a program (**script**) to create a simple pattern. The investigation comprises of four activities.

- Activity 1.1.1 - Drag and Stamp
- Activity 1.1.2 - Drag, Turn and Stamp
- Activity 1.1.3 - Move, Turn and Stamp
- Activity 1.1.4 - Unplugged Simple Scripts

Activity 1.1.1: 10-15 mins | Activity 1.1.2: 15-20 mins | Activity 1.1.3: 20-25 mins | Activity 1.1.4: 10-15 mins

We recommend allowing 60 to 90 minutes for this investigation.

Scratch starter projects:

- 1-Tile Stamp
- 1-Tile Turn
- 1-Tile Move

LINKS TO PRIMARY NATIONAL CURRICULUM

Computer Science	Link with Scratch/Maths
<p>Computing Design, write and debug simple programs that accomplish specific goals.</p>	<ul style="list-style-type: none"> Pupils are required to create a script that produces a pattern.
<p>Mathematics Identify, describe and represent the position of a shape following translation. Recognise angles as a combination of a turn, trace angles or measured in degrees, identify different types of angles and use angle sum facts.</p>	<ul style="list-style-type: none"> Pupils are required to create patterns with one or more lines of symmetry. Pupils are required to move and stamp their sprite to create patterns. Pupils are required to use their knowledge of angles to make their sprite and create different patterns.

MODULE 1 - INVESTIGATION 1 - ACTIVITY 1.1.1 Drag and Stamp

Learning Objectives:
Explain how to drag and stamp a sprite to create symmetrical patterns. Explain what is happening when the green flag is clicked.

Activity Instructions:

- Pupils open project **1-Tile Stamp**, save as a copy and add their name(s) to the title.
- Pupils create a symmetrical pattern by dragging the Tile sprite and clicking on the **stamp** block in the scripts area.

- Pupils can save their pattern by right-clicking (or Shift + click) on the stage and selecting **save picture of stage**.
- Pupils click on the green flag to run the **setup script** - this resets the stage and the sprite.

Things to Note:

- The **setup script** should not be modified.
- Stamped patterns are not saved in your project - you can only save a picture of the whole stage.
- You need to click on the stamp block carefully to make sure it turns (look to see if the green flag flashes).

Checklist for Pupil:

- How many stamps have you used?
- What colour is the stamp block? Which group of blocks does it belong to? Where can we find it?
- Do you have any problems with stamping?
- Have you clicked on the green flag to start again? What happens? Why do you think it does this?
- What does **go to x,y** mean? (go to centre of stage)
- When the sprite is moved what happens to the x,y coordinates?
- What makes your pattern symmetrical?
- How many lines of symmetry does your pattern have?

Unplugged:
A **sprite** is an object.
The **stage** is where you can see the sprites.
A **block** represents a command which tells the sprite what to do and you can run by clicking on it.
The **stamp** block tells the sprite to print an image of itself on the stage.
The **when green flag clicked** block is called a **hot block**. It is always placed at the top of a script.

INVESTIGATION 1 Activity 1.1.1

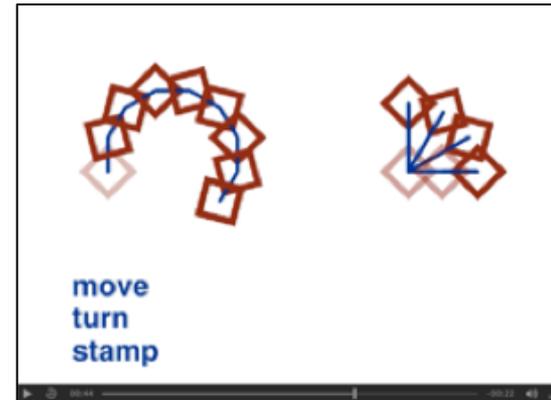
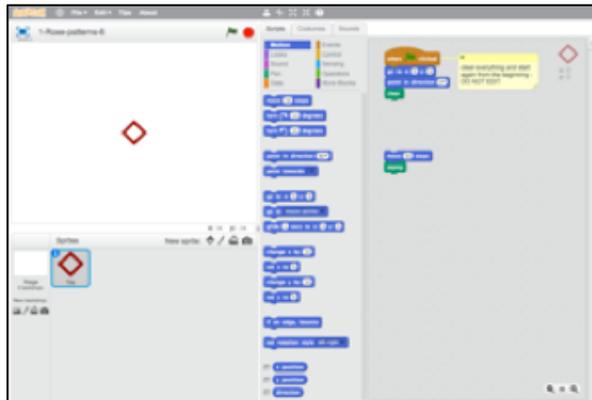
This screenshot shows the names given to the different areas of the Scratch interface.

Use this cut-out to show your pupils what the Tile sprite is and that is pointing north.

In the later activities it can be used to demonstrate turning and moving.

When using the cut-out to demonstrate turning it is important to show the rotation point is at the bottom of the tile.

Scratch Starter Projects



Support Videos

Presentation Slides for every lesson

BETLE GEOMETRY
MODULE 2: INVESTIGATION 3

Discovering Dots

MODULE 2: INVESTIGATION 3
Activity 2.3.2 – Unplugged: Picture Predictions

Read each of the scripts. Draw and/or explain in words the picture that it will create.

MODULE 2: INVESTIGATION 3
Activity 2.3.3 – Swarming Dots

Replace the **move** and **turn** blocks in your script with the **jump to random position** block from the **More Blocks** group and run the script.

Try switching the backdrop to **night** or **day** by using the **switch backdrop to ...** block.

Additional challenges, vocabulary and reference posters

MODULE 2 • CHALLENGE 4
AROUND THE GLOBE CHALLENGE

In Module 2 we used the "forward + stamp + move backward + turn" algorithm to create circular patterns with the sprite starting and finishing in the centre. The same algorithm may help us now to create different circular patterns.

Combine drawing a larger disc with drawing houses, trees, mushrooms or other objects around the outside edge. Be sure that the Beetle always returns back to the same position in the centre, then turns a bit and repeats.

MODULE 2 • VOCABULARY

- pen tool** each sprite has a pen tool and can draw lines on the stage when its pen tool is down.
- set pen blocks** allow you to change the colour, size (width) and shade of the line that is drawn.
 - set pen colour to
 - set pen size to
 - set pen shade to
- pen down** after running this block, the sprite will continuously draw a trail wherever it moves (until pen up block is used).
- pen up** after running this block, the sprite will stop drawing a trail while it moves (until pen down block is used again).
- backdrop** the background of the stage: there can be multiple backdrops and the stage can change its look to display any of them by
 - switch backdrop to colour
- pick random** picks a random integer number within a specified interval. For example can be used in
 - set pen size to pick random to 45

MODULE 2 • POSTER 2
SCRATCH COLOUR SCHEME – PEN SHADES

Each colour that you set using **set pen colour to** or **pick random to** may have 100 different pen shades. If the pen shade is 0, then the colour will be very dark. If the pen shade is 100, the colour will be close to white. The default pen shade setting (that is, when you do not set it at all) is 50, a shade in the middle between very dark and very light.

The ScratchMaths Pedagogy: “The five Es”

Explore	Learning through exploration enables pupils to deal with different constraints and ambiguity through employing skills such as iterative thinking, problem solving and creativity. We therefore advocate the provision of opportunities to investigate key ScratchMaths ideas and try things out as well as to experiment with different strategies for debugging.
Explain	A crucial aspect of understanding ideas is being able to explain what has been learned and articulating the reasons behind a chosen approach. This helps with clarifying ideas, simply expressing them explicitly as well as in answering questions from peers. We encourage the incorporation of reflective questions and opportunities for discussion with others about the ideas that pupils have been exploring during ScratchMaths lessons.
Envisage	It is important to have a goal in mind when building a computer program and to predict what the outcome might be before trying it out. We believe in providing opportunities for the consideration of a program goal and encouragement to predict potential outcomes when using different strategies to realise this goal.
Exchange	Collaborating and sharing is a powerful way to learn. This allows you to ‘decentre’, while trying to see a problem from another’s perspective as well as defend your own approach and compare it with others. We suggest the inclusion of meaningful opportunities to share and build on others’ ideas, whilst acknowledging the on-going development of collaboration skills and providing appropriate scaffolding for these activities.
bridgE	To make connections between programming and mathematics the ideas developed through Scratch programming have to be re-contextualised and re-built in the language of mathematics. We recommend any links with conventional mathematics to be made explicit during the activities and also for the provision of opportunities to re-contextualise their learning in an environment outside of Scratch.

Module 1 - Overview

Module	Investigation	Computing concepts (+ Scratch terms)	Mathematics concepts
Module 1: Tiling Patterns 	<i>1.1 Moving, Turning and Stamping</i>	Sprite and its attributes Command, command with input (stamp, move, turn) Program, sequence of commands	<ul style="list-style-type: none">• (Y2) Patterns• (Y2) Rotation• (Y3) Angles• (Y4) Coordinates• (Y4) Symmetry• (Y4) Multiplication• (Y5) Translation• (Y5) Transformation• (Y5) Sequences• (Y5) Positive and negative numbers
	<i>1.2 Repeating and Alternating Patterns</i>	Control structures, repetition (repeat) Designing, building and debugging programs (costume)	
	<i>1.3 Circular Rose Patterns</i>	Algorithms Logical reasoning	
	<i>1.4 Defining your own Pattern Blocks</i>	Defining new commands (make a new block)	

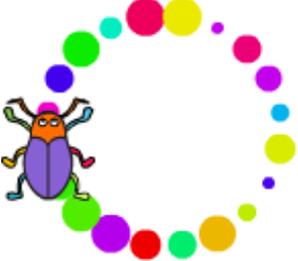
Module 1 - Structure

The **red** dashed line indicates the core activities which are important to complete before moving on to the next activities.

For activities which require pupils to continue with a project from a previous lesson you can alternatively use the suggested INT project for those pupils who do not have a project to continue with or if you wish all pupils to begin from the same point.

	Activity 1	Activity 2	Activity 3	Activity 4
Investigation 1 Moving, Turning and Stamping 	Drag and Stamp Starter project: 1-Tile Stamp	Drag, Turn and Stamp Starter project: 1-Tile Stamp	Move, Turn and Stamp Starter project: 1-Tile Move	Unplugged: Simple Scripts
Investigation 2 Repeating and Alternating Patterns 	Repeating Flowers Starter project: 1-Tile Repeat	Unplugged: Calculating Angles	Alternating Flowers Continue with: 1-Tile Repeat	Repeating and Alternating (EXT) Continue with: 1-Tile Repeat
Investigation 3 Creating Circular Rose Patterns 	Moving Forwards and Backwards Starter project: 1-Rose Patterns	Unplugged: Predicting Patterns	Combining Different Costumes Continue with: 1-Rose Patterns	
Investigation 4 Defining Your Own Pattern Blocks 	Defining Your Own Pattern Blocks Continue with: 1-Rose Patterns	Unplugged Assessment: Reading Scripts 1	Building a Row of Roses (EXT) Continue with: 1-Rose patterns	Rose of Roses (EXT) Continue with: 1-Rose patterns

Module 2 - Overview

Module	Investigation	Computing concepts (+ Scratch terms)	Mathematics concepts
Module 2: Beetle Geometry 	<i>2.1 Exploring Pen</i>	Pen and its attributes (pen blocks) Sequencing	<ul style="list-style-type: none">• (Y4) Perimeter• (Y4) Coordinates• (Y5) Roman numerals• (Y5) Regular and irregular polygons• (Y5) Multiplication• (Y5) Angles• (Y5) Rotation• (Y5) Positive and negative numbers• (KS3) Random numbers
	<i>2.2 Drawing Polygons</i>	Defining new commands Problem solving	
	<i>2.3 Discovering Dots</i>	Randomness (pick random) Backdrop of the stage (backdrop)	
	<i>2.4 Pen Project: Nature Scenes</i>	Decomposing problems Project	

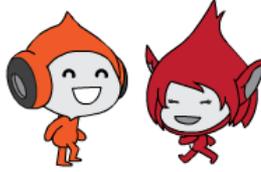
Module 2 - Structure

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	Activity 1	Activity 2	Activity 3	Activity 4
Investigation 1 Exploring Pen 	Drawing Numerals Starter project: 2-Drawing Numerals	Swapping Blocks Starter project: 2-Swapping Blocks	Unplugged: I am Beetle	Different Drawing Algorithms Continue with: 2-Swapping Blocks
Investigation 2 Drawing Polygons 	Drawing Regular Polygons Starter project: 2-Drawing Polygons	Unplugged: Polygon Scripts	Using and Defining More Blocks Continue with: 2-Drawing Polygons	Combining More Blocks Continue with: 2-Drawing Polygons
Investigation 3 Discovering Dots 	Dots and Dashes Starter project: 2-Dots and Dashes	Unplugged: Picture Predictions	Swarming Dots Continue with: 5-Grid World or start with: 5-Grid World INT2	A Sky Full of Stars
Investigation 4 Pen Project: Nature Scenes 	Drawing Trees Starter Project: 2-Pen Project	Unplugged Assessment: Reading Scripts 2	A Walk in the Woods (EXT) Continue with: 2-Pen Project	Life's a Beach (EXT) Continue with: 2-Pen Project

Module 3 - Overview

Module	Investigation	Computing concepts (+ Scratch terms)	Mathematics concepts
Module 3: Collaborating Sprites  Nano Tera  Pico Giga	<i>3.1 Animating Sprites</i>	Graphic effects (hide, show, ghost) Position (point towards, change y) Control structures (forever, if on edge, bounce)	<ul style="list-style-type: none"> • (Y2) Rotation • (Y5) Multiplication (factors) • (Y5) Reflection • (Y5/6) Positive and negative numbers • (Y6) Coordinates • (KS3) Random numbers • (KS3) Order positive and negative integers (Use the symbols <, >) • (KS3) Aspects of working mathematically
	<i>3.2 Encountering Conditions</i>	Conditions (touching) Control structures (repeat until, if selection) Operators and expressions (<, >)	
	<i>3.3 Broadcasting Messages</i>	Broadcasting (broadcast, when I receive) Parallel behaviours	
	<i>3.4 Interactive Stories</i>	Communication and collaboration	

Module 3 - Structure

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	Activity 1	Activity 2	Activity 3	Activity 4
Investigation 1 Animating Sprites 	Multiple Sprites Starter project: 3-Multiple Sprites	Teleporting Nano Continue with: 3-Multiple Sprites	Jumping Tera Continue with: 3-Multiple Sprites	Walking Pico Continue with: 3-Multiple Sprites
Investigation 2 Encountering Conditions 	Repeat Until Continue with: 3-Multiple Sprites	Touching Colour Continue with: 3-Multiple Sprites	Walking in the Air Continue with: 3-Multiple Sprites	Unplugged: True or False
Investigation 3 Broadcasting Messages 	Unplugged: Broadcast and Review	Introduction: One to One Continue with: 3-Multiple Sprites	Come to Tera: One to Many Continue with: 3-Multiple Sprites	
Investigation 4 Interactive Stories 	Unplugged Assessment: Reading Scripts 3	The Story of the Sprites (EXT) Continue with: 3-Multiple Sprites or 3-Multiple Sprites4		

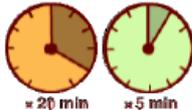
Module 4 - Overview

Module	Investigation	Mathematics links	Computing links
Module 4: Building with Numbers  	<i>4.1 Place Value Models</i>	(Y6) Practical problems involving place value (Y6) Mental calculations (Y6) Sequences (KS3) Random numbers	<ul style="list-style-type: none"> • Events • Repetition and Control structures (repeat, forever, if selection) • Operators and expressions (<, =, >) • Broadcasting (broadcast, when I receive) • Conditions (touching) • Position (go to, point in direction) • Stamp and Pen • Randomness (pick random) • Parallel behaviours • Defining new commands • Logical reasoning • Decomposition
	<i>4.2 Timers and Stopwatches</i>	(Y3) Subtraction (Y4) Time (Y6) Coordinates (Y6) Practical problems involving place value (Y6) Angles	
	<i>4.3 The Conversion Game</i>	(Y4) Multiplication (Y6) Practical problems involving place value (Y6) Mental calculations (Y6) Estimation (KS3) Random numbers Mathematical fluency, reasoning and problem solving	
	<i>4.4 Exploring Conversions</i>	(Y5) Fractions (Y6) Conversions: Length, Weight, Time (Y6) Practical problems involving place value	

Module 4 - Structure

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	Activity 1	Activity 2	Activity 3	Activity 4
Investigation 1 Place Value Models 	Digits Up, Digits Down Starter project: 4-Dials Up	Unplugged: Flip Flip Nudge Nudge	Playing with Place Value Continue with: 4-Digits Up	Sequences Starter project: 4-Sequences
Investigation 2 Timers and Stopwatches 	Build a Stopwatch Starter project: 4-Stopwatch	Unplugged: Nudge Nudge Get Get	Countdown Conundrum Starter project: 4-Timer	Dizzy Dials Starter project: 4-Dials
Investigation 3 The Conversion Game 	Unplugged: Playing the Conversion Game	Building Conv. Game: The Display Continue with: 4-Conversion Game	Building Conv. Game: Conversion Houses Continue with: 4-Conversion Game or start with: 4-Conversion Game INT1	Building Conv. Game: Record Keeping Continue with: 4-Conversion Game or start with: 4-Conversion Game INT2
Investigation 4 Exploring Conversions 	Converting Length Starter project: 4-Converting Length	Converting Mass Starter project: 4-Converting Mass	Converting Time Starter project: 4-Converting Time	

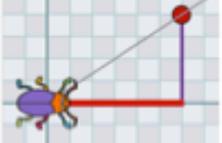
Module 5 - Overview

Module	Investigation	Mathematics links	Computing links
Module 5: Exploring Mathematical Relationships	<i>5.1 Polygon Fireworks, Night Skyline</i>	(Y4) Multiplication and division (Y5) Perimeter (Y5) Factor pairs (Y5) Regular and irregular polygons (Y6) Algebra (Y6) Angles (Y6) Coordinates (KS3) Random numbers	<ul style="list-style-type: none"> • Events • Repetition and Control structures (repeat, forever, if selection) • Variable • Sequence of commands • Pen • Randomness • Defining new commands • Operators and expressions (+, *, /) • Position (go to, change x by) • Backdrops • Logical Reasoning • Decomposition
	<i>5.2 Mathematically Similar Rectangles</i>	(Y6) Regular polygons (Y6) Ratio and proportion of similar shapes	
	<i>5.3 Grid World: For Exploring Proportionality</i>	(Y6) Coordinates (Y6) Algebra (Y6) Ratio and proportion of similar shapes	
	<i>5.4 Exploring Proportionality</i>	(Y6) Ratio and proportion of similar shapes	

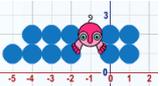
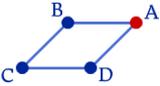
Module 5 - Structure

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	Activity 1	Activity 2	Activity 3	Activity 4
Investigation 1 Polygon Fireworks, Night Skyline 	Ask and Answer Starter project: 5-Polygon Firework	Unplugged: Polygon Predictions	Naming Values Continue with: 5-Polygon Firework or start with: 5-Polygon Firework INT1	The Sky at Night Continue with: 5-Polygon Firework or start with: 5-Polygon Firework INT2
Investigation 2 Mathematically Similar Rectangles 	Sequences of Squares Starter project: 5-Altering Polygons	Altering Rectangles Continue with: 5-Altering Polygons	Exploring Mathematical Similarity Continue with: 5-Altering Polygons	Unplugged: Rectangle Jungle
Investigation 3 Grid World: For Exploring Similarity 	Enter the Grid World Starter project: 5-Grid World	Connecting Corners Continue with: 5-Grid World or start with: 5-Grid World INT1	Meet the Magic Line Continue with: 5-Grid World or start with: 5-Grid World INT2	Unplugged: Module 5 Assessment
Investigation 4 Exploring Proportionality 	Using the Grid World Continue with: 5-Grid World or start with: 5-Grid World FINAL			

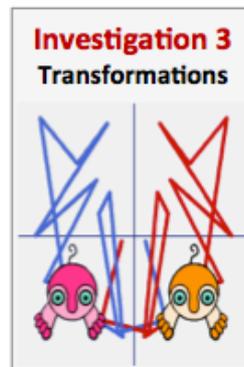
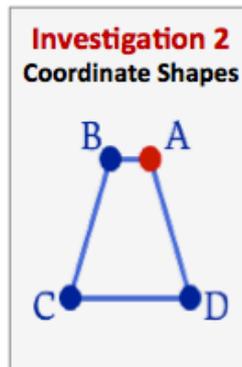
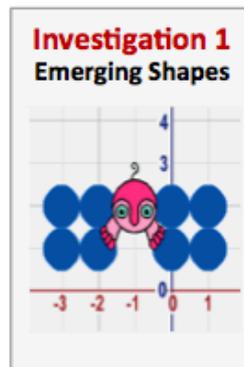
Module 6 - Overview

Module	Investigation	Mathematics links	Computing links
<p>Module 6: Coordinates and Geometry</p>  	<p><i>6.1 Emerging Shapes</i></p>	<p>(Y5) Reflection and Translation (Y6) Coordinates (Y6) Scale Factor (KS3) Random numbers</p>	<ul style="list-style-type: none"> • Events • Animation • Repetition and Control structures (repeat, forever) • Variable • Selection (when key pressed) • Stamp and Pen • Randomness • Defining new commands • Operators and expressions (+, -, *, /, round) • Position and Direction (go to, set/change x by, set/change y by, point in direction) • Backdrops • Logical reasoning • Decomposition
	<p><i>6.2 Coordinate Shapes</i></p>	<p>(Y5) Regular and irregular polygons (Y6) Coordinates (Y6) Division and rounding (Y6) Scale Factor</p>	
	<p><i>6.3 Transformations</i></p>	<p>(Y5) Regular and irregular polygons (Y5) Reflection and Translation (Y6) Coordinates (Y6) Scale Factor</p>	

Module 6 - Structure

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Activity 1	Activity 2	Activity 3	Activity 4
Restless Fleeeee Starter project: 6-Fleeeee Dots	Unplugged and Hands-on: Envisage and Explore	Introducing Scale Continue with: 6-Fleeeee Dots	Dotty Patterns Continue with: 6-Fleeeee Dots
Letters and Coordinates Starter project: 6-Grid Letters	Busy Fleeeee and Clever Points Starter project: 6-Coordinates	Tricky Triangles Continue with: 6-Coordinates or start with: 6-Coordinates INT1	Quirky Quadrilaterals Continue with: 6-Coordinates or start with: 6-Coordinates INT2
Mimic Meeeee Starter project: 6-Mimic Meeeee	Shadows, Translations & Reflections Continue with: 6-Mimic Meeeee or start with: 6-Mimic Meeeee INT	Through the Looking Glass Starter project: 6-Looking Glass	