



### 1 About this unit

- Software:** Inkscape/Adobe Illustrator/CorelDRAW, Scratch, Terragen Classic, Logo
- Apps:** Adobe Ideas/neu.draw, Snap!
- Hardware:** Laptop or desktop computers/tablets
- Outcome:** Pieces of geometric art and a Scratch computer program for drawing shapes



## UNIT SUMMARY

The pupils use vector and turtle graphics to explore geometric art, taking inspiration from the work of Escher, Riley and traditional Islamic artists, as well as experimenting with complex 'fractal' landscapes.

## CURRICULUM LINKS

### Computing PoS

- Use sequence, selection, and repetition in programs; work with variables and various forms of input and output.
- Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs.
- Select, use and combine a variety of software (including internet services) on a range of digital devices to design and create a range of programs, systems and content that accomplish given goals, including collecting, analysing, evaluating and presenting data and information.

### Suggested subject links

- Art and design:** The children learn about some famous artists.
- Maths:** This unit draws on pupils' knowledge of angles, 2D shapes, translations and that angles at a point total 360°.
- RE:** There are opportunities to explore Islamic art.
- PE:** The pupils can explore turtle graphics instructions within a PE or dance context.

## TRANSLATING THE COMPUTING PoS

- Pupils use a *variety of software* (vector graphics, turtle graphics and terrain rendering tools) to *design and create digital content*, in this case geometric art. This art can be seen as *presenting*

*information*. The pupils can compare the simplicity of the instructions with the complexity of the images, and consider how the *algorithms* achieve effects.

- The turtle graphics work in this unit provides another opportunity for the pupils to develop their programming skills, drawing on *sequence and repetition* ideas, as well as *logical reasoning, algorithmic thinking* and debugging, which the pupils will be familiar with from other programming work.

## LEARNING EXPECTATIONS

This unit will enable the children to:

- develop an appreciation of the links between geometry and art
- become familiar with the tools and techniques of a vector graphics package
- develop an understanding of turtle graphics
- experiment with the tools available, refining and developing their work as they apply their own criteria to evaluate it and receive feedback from their peers
- develop some awareness of computer-generated art, in particular fractal-based landscapes.

The assessment guidance on page 40 will help you to decide whether the children have met these expectations.

## VARIATIONS TO TRY

- The pupils could explore patterns in plants, or the regular structures of crystals.
- Architecture provides an interesting context for repeating patterns and structures.
- You could use Logo instead of Scratch for the turtle graphics activities in this unit.

## 2 Getting ready

### THINGS TO DO

- Read the *Core steps* sections of *Running the task*.
- Decide which software/tools are most accessible/appropriate for use with your class.
- Download your chosen software/tools (see *Useful links*) and spend some time familiarising yourself with them.
- Watch the *Software in 60 seconds* walkthroughs for this unit.
- Think about the individuals and groups you have in your class. Could you use any of the *Extensions* on pages 34–39 to extend your more able children? Could you use any of the suggestions in *Inclusion* (see below) to support children with specific needs, e.g. SEN or EAL? Have you considered

how a Teaching Assistant will support you and the children, if one is available?

- Ensure you have sufficient computers/laptops/tablets and other equipment booked in advance.
- If you will be going off site for this work, make the necessary arrangements.

### THINGS YOU NEED

- Computers/laptops/tablets loaded with, or having access to, the software/tools you have chosen
- Internet access
- Relevant exemplification downloaded from the web (see *Useful links*)
- Examples of geometric patterns and art (as a presentation or IWB file)
- Digital cameras
- Art resources
- Maths equipment



### CD-ROM RESOURCES

- *Software in 60 seconds* – Inkscape (1, 2 and 3)
- *Software in 60 seconds* – Scratch (7)
- *Software in 60 seconds* – Terragen (1, 2)
- Unit poster – Examples of tessellations
- Pupil self-assessment information



### E-SAFETY

- If the pupils use Google Image Search to study examples of artists' work, ensure that 'safe search' is locked to 'strict'.
- Precautions over the protection of identity and intellectual property should be in place if the pupils upload work they create for others to see – you may wish to limit this to the school learning platform or website.



### INCLUSION

- Much of this unit will require precise mouse skills, so some pupils may benefit from access to alternative interfaces such as tablets, trackballs or even the IWB.
- Pupils with visual impairment may need additional assistive technology (see [www.abilitynet.org.uk/](http://www.abilitynet.org.uk/)), or you may wish to explore ideas of pattern, repetition and change through other media, such as music and sound.
- Some pupils may struggle with the mathematical demands of the turtle graphics work, and may need additional support.



### USEFUL LINKS

#### Software and tools

- Inkscape: <http://inkscape.org/download/>.
- Scratch: <http://scratch.mit.edu>.
- [www.shodor.org/interactivate/activities/Tessellate/](http://www.shodor.org/interactivate/activities/Tessellate/) provides a simple web-based interactive interface for exploring tessellations. Please note, Java is required to view this website.
- Two alternatives to Inkscape are Adobe Illustrator [www.adobe.com/products/illustrator/](http://www.adobe.com/products/illustrator/) and CorelDRAW [www.corel.com](http://www.corel.com).
- Terragen Classic is available at <http://planetside.co.uk/terragen-classic-windows-download>. (Note that OS X versions after 10.7 are not supported.)

#### Online tutorials

- Inkscape: <http://inkscape.org/doc/basic/tutorial-basic.html>.  
<http://inkscapetutorials.wordpress.com/>.  
<http://screencasters.heathenx.org/>.  
[www.youtube.com/watch?v=XnUH-k8zGbY](http://www.youtube.com/watch?v=XnUH-k8zGbY).
- Scratch: [http://info.scratch.mit.edu/Video\\_Tutorials](http://info.scratch.mit.edu/Video_Tutorials).
- Turtle graphics in Scratch: [www.youtube.com/watch?v=JO2BTc7s38I](http://www.youtube.com/watch?v=JO2BTc7s38I).
- Terragen: [www.youtube.com/watch?v=5kAoNqRoxCs](http://www.youtube.com/watch?v=5kAoNqRoxCs).

#### Information and ideas

- Geometric Islamic art: [www.patterninislamicart.com/](http://www.patterninislamicart.com/).
- Escher's art: [www.mcescher.com/](http://www.mcescher.com/) or [www.mcescher.com/Gallery/gallery.htm](http://www.mcescher.com/Gallery/gallery.htm).
- Bridget Riley's art: [www.karstenschubert.com/bridget-riley](http://www.karstenschubert.com/bridget-riley) and [www.op-art.co.uk/bridget-riley/](http://www.op-art.co.uk/bridget-riley/).
- TurtleArt: <http://turtleart.org/gallery/index.html>.
- Terragen scenes: <http://planetside.co.uk/galleries/terragen-gallery> (created by later versions of the software).

### 3 Running the task – We are artists

**Software:** Inkscape/Adobe Illustrator/CorelDRAW, Scratch, Terragen Classic, Logo **Apps:** Adobe Ideas/neu.draw, Snap!

**Hardware:** Laptop or desktop computers/tablets **Outcome:** Pieces of geometric art and a Scratch computer program for drawing shapes

## Core steps

### Step 1: Creating simple tessellations using Inkscape

#### RESOURCES

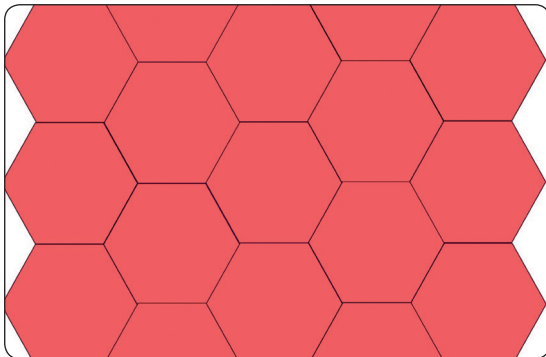


- *Software in 60 seconds* – Inkscape (1, 2, 3)
- Unit poster reverse – Examples of tessellations



- Repeating patterns: [www.pinterest.com/leoramd/tessellation-and-other-repeating-patterns](http://www.pinterest.com/leoramd/tessellation-and-other-repeating-patterns)

#### POSSIBLE OUTCOME FOR THIS STEP:



- Share the *Learning expectations* for the unit (see page 32) and explain the success criteria.
- Show the pupils a selection of photos of tessellating patterns made from a single shape. You could also show the unit poster with examples of more complex tessellations. Revise the definition of a tessellation (a repeating pattern of shapes that fit perfectly together).
- Ask the pupils to find examples of tessellations in the environment, recording them with a digital camera.
- If appropriate, play the *Software in 60 seconds* walkthroughs 1–3. Give the pupils time to experiment with the software. Introduce Inkscape.
- Model how to set a document up for accurate drawing. In File > Document Properties, set the units to 'cm', create a grid and turn the 'Snap' options on. Ask the pupils to create a few possible polygons and experiment with gradient fills, discussing with each other which shapes will tessellate. Triangles and quadrilaterals will always be safe bets!
- Deleting all but one of the shapes, ask pupils to use copy and paste (and perhaps the transformation tools and group) to fill the page with copies of their shape, ensuring each shape fits exactly against its neighbour (use the second button on the 'snap bar' on the right-hand side to help with this).

## Extensions

### SCHOOL

- You could challenge some pupils to find all the regular polygons that tessellate with themselves. (There are three: the hexagon, the equilateral triangle and the square.)

### HOME

- Encourage pupils to take photos of tessellating patterns in and around their home to bring into school to show the class.

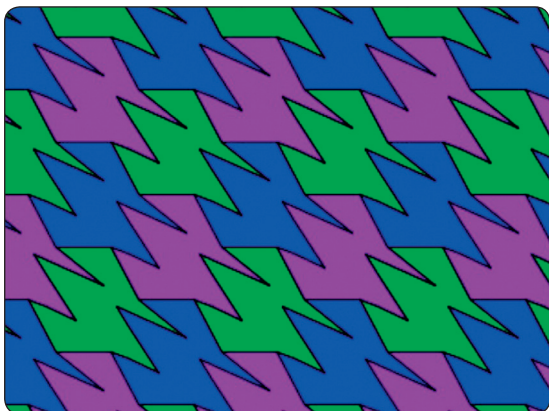
## Step 2: Creating more complex tessellations using Inkscape

### RESOURCES



- Interactivate: [www.shodor.org/interactivate/activities/Tessellate/](http://www.shodor.org/interactivate/activities/Tessellate/)

### POSSIBLE OUTCOME FOR THIS STEP:



- Invite pupils to research Maurits Escher's work, particularly his pieces based on tessellations. A quick way to do this would be to type 'Escher tessellations' into a Google image search, ensuring that safe search is locked in place.
- Ask pupils to describe what they can see. Are the tessellations simple or complex? How do they think Escher created these tessellations? Children could investigate whether all shapes can tessellate (they can't), or work out which shapes can.
- Encourage pupils to create and experiment with tessellating patterns, using simple interactive tools such as the one listed in *Resources*.
- In pairs, invite the pupils to find a more complicated shape that will tessellate, perhaps experimenting first on paper, and then to try out their idea using Inkscape. Initial letters made out of unit squares can be quite effective. The pupils might also like to experiment with using alternating colours in a repeating pattern.
- Ask the pupils to use copy and paste (and perhaps the transformation tools and group) to fill the page with copies of their shape, ensuring each shape fits exactly against its neighbour (remind pupils that the second option, 'snap bounding box', on the right-hand side snap bar helps with this). The pupils need to pay attention to detail – if their patterns are to be printed out, even small errors in fitting shapes together will spoil an otherwise effective design. It is worth taking time over this, making the most of the tools available to enable experimentation, interaction, and trial and improvement approaches.

### SCHOOL

- More complex effects can be obtained by applying bitmap filters, particularly warp-style filters, to the completed tessellations, allowing visual effects to be applied to the whole of the image, such as distorting the image to create a 'fish-eye' or spherical projection effect, as in some of Escher's work.

### HOME

- Encourage pupils to download a copy of Inkscape to use on their home computers, exploring its functionality further for themselves.



# Core steps

## Step 3: Programming Islamic-style art in Scratch

### RESOURCES

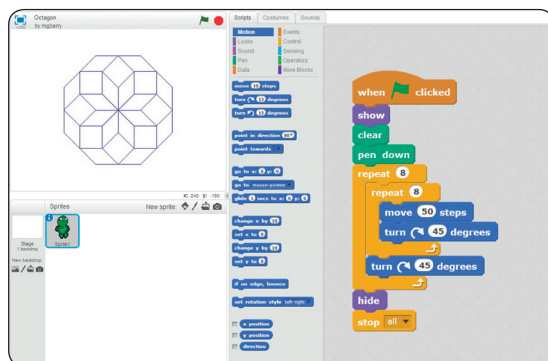


- *Software in 60 seconds* – Scratch (7)



- <http://scratch.mit.edu/projects/15513542/#editor>
- [www.patterninislamicart.com/](http://www.patterninislamicart.com/)

### POSSIBLE OUTCOME FOR THIS STEP:



- This step provides an alternative approach to working with repeating patterns, taking inspiration from the geometric art of Islam.
- Look at some examples of geometric Islamic art as a class, or ask pupils to research this for themselves.
- Explain to the children that they are going to use Scratch to create some Islamic-style art. Ask one or more pupils to remind the class of Scratch's interface, focusing on the Pen and Clear commands (found in the *Pen* palette) as well as commands in the *Motion* and *Control* palettes. You might wish to replace the default cat sprite with a turtle, and make it a bit smaller, either using the shrink tool at the top of the screen, or by using the *set size to* block on the *Looks* palette.
- Ask the pupils to work out how to draw some basic shapes in Scratch, such as equilateral triangles and squares.
- Show the pupils how to make a new block in the *Blocks* palette, as a way to create their own procedures in Scratch (see the *Software in 60 seconds* walkthrough in *Resources*).
- Show how to create complex geometric figures very simply by repeatedly drawing a simple shape then turning through a set angle, and perhaps moving forward. Draw the pupils' attention to the relationship between the angle of turn and the number in a repeating loop to complete a whole turn. For example, if the angle of turn were 60 degrees, pupils would need to repeat six times to complete the whole turn.
- Invite pupils to experiment with shape scripts, and perhaps some of Scratch's other graphics functions, such as set pen colour, shade and size on the *Pen* palette, to create a design inspired by Islamic geometric art.

# Extensions

## SCHOOL

- Some pupils might experiment with using Scratch to create recursive fractal designs, such as trees (<http://scratch.mit.edu/projects/14663891/>), the Sierpinski triangle ([http://scratch.mit.edu/search/google\\_results/?q=sierpinski&date=anytime&sort\\_by=datetime\\_shared](http://scratch.mit.edu/search/google_results/?q=sierpinski&date=anytime&sort_by=datetime_shared)) or the Koch snowflake ([http://scratch.mit.edu/search/google\\_results/?q=koch+snowflake&date=anytime&sort\\_by=datetime\\_shared](http://scratch.mit.edu/search/google_results/?q=koch+snowflake&date=anytime&sort_by=datetime_shared)).

## HOME

- Pupils could continue to work in Scratch at home, showing their work to their parents.

## Step 4: Using Inkscape to create art in the later style of Bridget Riley

### RESOURCES



- Bridget Riley's artwork: [www.karstenschubert.com/bridget-riley/](http://www.karstenschubert.com/bridget-riley/)
- [www.op-art.co.uk/bridget-riley/](http://www.op-art.co.uk/bridget-riley/)

### POSSIBLE OUTCOME FOR THIS STEP:



- Show some examples of Bridget Riley's later work, which features overlapping regular shapes with colours chosen from a restricted palette, or an irregular placement of open circles on a regular grid. A safe image search on Google should provide some examples.
- Help pupils to identify the characteristics of Bridget Riley's later work, and to set some criteria by which they'll be able to judge the success of their own creations. The pupils might like to experiment with sketching ideas on paper for this.
- Taking Riley's work as an inspiration, the pupils return to Inkscape and experiment with creating similar designs, referring back to the characteristics and criteria identified earlier. They can do this by copying and pasting a base shape, then changing its colour, or perhaps working with a small set of base shapes to copy and paste, each with its own colour. The pupils could experiment with different starting shapes.
- Encourage pupils to try different placements of objects, or to change the colour of several shapes, comparing the two versions (using undo/redo) to decide which is more effective. Emphasise how the nature of computer-based work makes it possible to try ideas out and change things later (unlike a drawing in pen).
- The pupils could experiment with different layering options and achieve a pleasing effect by setting their shapes' opacity to less than 100% (i.e. making them transparent).
- Ask the pupils to save several different versions of their work. If time permits, ask them to review, in pairs and as a whole class, which pieces are most successful, taking into account the success criteria they set at the start of the lesson.

### SCHOOL

- Some pupils could create Islamic-style art using Inkscape. Alternatively, they could explore repeating patterns in a 3D environment, such as Trimble SketchUp (see [www.sketchup.com/download](http://www.sketchup.com/download)).

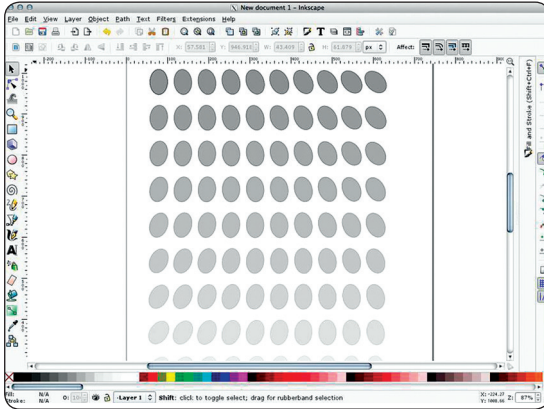
### HOME

- The pupils could continue to experiment with these techniques on their home computer, or perhaps explore how a similar effect could be achieved using traditional media.

# Core steps

## Step 5: Using Inkscape to create art in the early style of Bridget Riley

### POSSIBLE OUTCOME FOR THIS STEP:



- Provide early examples of Bridget Riley's work, in which she achieved 'Op Art' effects by gradually modifying the properties of shapes (typically lines, curves and circles) over one or two dimensions. Ask pupils to use the web to research further examples of Bridget Riley's early work. An image search using Google SafeSearch would be effective.
- Help pupils to identify the main characteristics of Bridget Riley's early work, and use these to set success criteria for judging their own work.
- Encourage pupils to begin to experiment in Inkscape by using copy and paste editing as before, gradually modifying the properties of their shapes across rows, columns or both.
- Demonstrate how Inkscape's Edit > Clone > Create Tiled Clone tool can be used to automate this process, encouraging pupils to experiment with the settings to produce a picture similar to Bridget Riley's early pieces. Tiled clones are linked to the original base shape created. Pupils should experiment with the effects that can be achieved by changing the base shape, and seeing the effect on the resulting pattern.
- Encourage pupils to explore the options for changing the size, orientation, colour, opacity and other properties of their shapes across the rows and columns of the resulting images.
- A further setting (the drop-down on the *Symmetry* tab) allows pupils to change the symmetry group (the underlying pattern) of their tiled clones. Encourage the pupils to experiment with how changing this setting affects the image.
- Encourage the pupils to share their work with the class, asking them to assess which pieces are most successful and using the success criteria they set at the start of the lesson.

# Extensions

## SCHOOL

- Some pupils could achieve similar effects using warp filters in bitmap editing software, such as the GIMP.

## HOME

- Pupils could continue to experiment with these techniques in their own copy of Inkscape at home, or using traditional media.

## Step 6: Creating computer-generated landscapes in Terragen Classic

### RESOURCES



- *Software in 60 seconds* – Terragen (1, 2)



- Terragen image gallery: <http://planetside.co.uk/galleries/terragen-gallery>

### POSSIBLE OUTCOME FOR THIS STEP:



- Show the pupils some examples from the online Terragen gallery (see *Resources*). Explain that these landscapes have been created using a computer program.
- Introduce pupils to the Terragen Classic interface. If appropriate, show the *Software in 60 seconds* walkthroughs on the CD-ROM.
- Show the pupils how to generate a random height field by using the landscape window and choosing 'Generate terrain'. Encourage them to experiment with some of the settings in this dialogue. Demonstrate how to use the surface map dialogue, which allows you to choose from the default surface options.
- Ask the pupils to return to the main Terragen Classic window. Demonstrate how to position the camera and produce a quick render in the main Terragen window. Encourage pupils to experiment with positioning the camera and altering its settings.
- Show the pupils the water dialogue, demonstrating how to set the water level. Encourage pupils to experiment with the settings in this dialogue and then return to the main window and try a quick render of their landscape.
- Demonstrate how the sunlight dialogue can be used to set the position of the sun, and encourage pupils to experiment with this, trying a quick render as they change settings.
- When the pupils feel they have an interesting image, show how to increase the render settings to produce a much higher resolution image. Ask the pupils to set their computers rendering their images and save the resulting pictures to show to one another in a plenary.
- Pupils should evaluate the success of their work. Some examples could be uploaded to the school learning platform, school website or an external site.

### SCHOOL

- Some pupils might like to experiment with the current version of Terragen, the user interface for which is considerably more complex.
- Some pupils could explore the cloud dialogue, experimenting with the controls and attempting a trial render. Similarly, you could ask some pupils to explore the atmosphere dialogue.

### HOME

- Pupils can download a copy of Terragen Classic to use at home, or they might like to show their pictures to their parents or carers, inviting them to guess how they were made.



## Assessment guidance

Use this page to assess the children's computing knowledge and skills. You may wish to use these statements in conjunction with the badges provided on the CD-ROM or community site and/or with your own school policy for assessing work.

### ALL CHILDREN SHOULD BE ABLE TO:

- Create a tessellating pattern
- Write a program to draw a simple shape
- Create a pattern using overlapping shapes
- Create a pattern using repeating, varied shapes
- Create a computer-generated landscape

### BADGE



### COMPUTING PoS REFERENCE

- Design and create content
- Design and create programs
- Design and create content
- Design and create content
- Design and create content

### MOST CHILDREN WILL BE ABLE TO:

- Create a tessellating pattern using more complex shapes
- Use repetition in a program to draw a more complex geometric figure
- Create a pattern using repeating, varied shapes using the tile clone tool or similar
- Create an aesthetically pleasing computer-generated landscape



- Design and create content
- Use sequence and repetition in programs
- Design and create content
- Be discerning in evaluating digital content

### SOME CHILDREN WILL BE ABLE TO:

- Use blocks of script they have written themselves to create a complex geometric figure in Scratch
- Explain in simple terms how computers can generate photorealistic landscapes



- Solve problems by decomposing them into smaller parts
- Use logical reasoning to explain how some simple algorithms work

### PROGRESSION

The following units will allow your children to develop their knowledge and skills further.

- *Unit 5.6 – We are architects*
- *Unit 6.4 – We are interface designers*

## 5

## Classroom ideas

Practical suggestions to bring this unit alive!



### DISPLAYS AND ACTIVITIES

- Books and posters featuring geometric art would provide further inspiration.
- Plastic/cardboard shapes might allow pupils to experiment with tessellating.
- Printouts of the best examples of each pupil's work would make a stunning display. You could even mount an exhibition of the pupils' work, perhaps inviting parents and carers for a private view.



### WEBLINKS

- Tessellation activities at NRICH: <http://nrich.maths.org/public/leg.php?code=-4&cl=3>.
- Images generated using Mathematica: <http://gallery.wolfram.com/>.
- TurtleArt software download from <http://ilk.media.mit.edu/courses/software/turtleart>.
- Images generated using TurtleArt: <http://turtleart.org/programming/samples/index.html>.
- Patterns in Islamic Art: <http://patterninislamicart.com>.
- Fractal art: [www.enchgallery.com/fractals/fracthumbs.htm](http://www.enchgallery.com/fractals/fracthumbs.htm).



### VISITS

- You could go for a walk around the local area to look for examples of repeating patterns, and capture examples on digital cameras.
- A visit to a graphic design studio (or a presentation by a graphic artist) would provide some insight

into how vector graphics software is used in the workplace.

- It may be possible to arrange a visit to a local mosque to explore aspects of Islamic art from a religious perspective.



### BOOKS

- Kirsanov, D. *The Book of Inkscape: The Definitive Guide to the Free Graphics Editor*. (No Starch Press, 2009)

#### On tessellations:

- Seymour, D. and Britton, J. *Introduction to Tessellations*. (Seymour (Dale) Publications, 1990)

#### On Escher:

- Escher, M.C. *The Graphic Work*. (Taschen, 2008)
- Hofstadter, D.R. *Gödel, Escher, Bach: An Eternal Golden Braid*. (Penguin Books, 2000)

#### On Islamic art:

- Broug, E. *Islamic Geometric Patterns*. (Thames and Hudson Ltd, 2008)
- Roeder, A. *Islamic Art Coloring Book*. (Prestel, 2010)

#### On Bridget Riley:

- Cooke, L., Kudielka, R. and Riley, B. *Paintings and Related Work 1983–2010*. (Ridinghouse, 2011)
- Riley, B. and Kudielka, R. *The Eye's Mind: Bridget Riley: Collected Writings 1965–2009*. (Thames and Hudson Ltd, 2009)

#### On the fractal nature of landscapes:

- Bell, S. *Landscape: Pattern, Perception and Process*. (Routledge, 2012)

## 6

## Taking it further

When you've finished, you might want to extend the project in the following ways.

- The children could be encouraged to look for different tiling patterns around their school.
- There are some interesting mathematical principles involved in tessellation, which you may wish to explore with the pupils – see the NRICH link in *Weblinks* above.
- There is scope to look at other artists creating work with a distinctly geometric character, including Josef Albers, Giacomo Balla, Ross Bleckner, Kasimir Malevich, Joseph Stella and Victor Vasarely.
- Some pupils might like to explore geometric art in 3D. Trimble SketchUp provides some tools for this. For an introduction to the program, see *Unit 5.6 – We are architects*.
- Exploring geometric art using traditional media would be a possible follow-up activity if pupils haven't engaged in such activities before.
- Inkscape is also a great program for creating snowflake images with six-fold symmetry.