

Mandalas

This project creates a beautiful design that connects to *Geometry* and *Patterning*, and can extend to *Number Sense*. Rotational symmetry inherently demonstrates the art principals of pattern, rhythm, and unity/harmony. They are both calm and dynamic at the same time. Some designs create an effect of rotation, while others are more of an explosion. This mandala project will allow you to focus specifically on the element of colour, and the math concepts of *repeating sequences*, *angles/degrees*, *rotational transformations*, and *fractions*. The art outcomes in this resource align with the Ontario curriculum. Look at the different grade adaptations for an idea that aligns with your local curriculum guides.

This lesson breaks down the steps to make the art and points out the math connections. You will see the hidden and overt math connections peppered throughout the procedure in square brackets [here's the math]. The math learning in this lesson will come through interacting with your students as they create. You will be able to notice and name the math they are using, describing the math to make it obvious, guiding them through proper application of the math, and building vocabulary. The math instruction that arises will depend on what you see and hear as they work.

Watch the free video that demonstrates how to do this project and highlights places where you can stop and focus on the math. You can find the video on TPT or on my Youtube channel, <http://www.youtube.com/c/RoyReedsWriting>

Inherent Math Outcomes

Geometry: Students will learn about transformational geometry, specifically turns/rotations. Learn about the symmetrical properties of squares and the relationships between squares and other shapes like triangles and rectangles.

Pattern: Students will observe how repeated actions and visual patterns are connected. They will explore making patterns using repeated colour changes.

Fractions: Students will experience proportional relationships between the whole and equal divisions of the whole, such as halves, quarters, and eighths.

Inherent Art Outcomes

Colour: Students will be able to explore the use of colour for expression (e.g., warm and cool colours) or to indicate a mood by playing with various colour schemes.

Tools and Materials

Large sheet of paper cut into a square (11x17 cut to size will work well)

Heavy card or Bristol board

A paperclip

Scissors

Pencil

Colouring media such as pencil crayon or marker

Masking tape

Procedure

1. If the paper is not already square, measure out a square based on the shorter edge, and trim the extra paper. [properties of a square, measuring]
2. Fold the large square piece of paper 4 times (horizontally, vertically, diagonally to the left, diagonally to the right). You have four lines going from edge to edge and corner to corner that intersect in the middle of the paper. [fractions, proportions, shape properties, symmetry]
3. Put a cross of tape where the folds cross on the back of the paper. This reinforces the paper to prevent tearing when tracing.
4. Bend one of the straight ends on a paperclip so when the paperclip is lying flat on the table, the end is pointing upward like a spike.
5. Use the paperclip spike to poke a hole in the square of paper at the point all the fold lines intersect.
6. Cut a long, interesting shape out of heavy card. Tips: the finished shape should be a little longer than half of the square paper. Keep the shape relatively simple on your first try with this activity. [proportion, length, measurement, estimation]
7. Decide which end of this cut shape is the widest. Draw an arrow tip at the very edge of this end of the shape. This will be used as a guide.
8. Take the end of the heavy card shape that *doesn't* have the arrow, and poke a hole into it with the paperclip spike. Tip: stay within 1cm of the edge of the paper, so the shape looks like a weird hand on a clock. [estimation]
9. *Rotate* the shape on the pin like a clock hand until the pencil arrow is lined up with one of the fold lines in the paper. [transformations, rotations]
10. Hold the shape in place and trace the outline of the shape. Tip: use a very sharp pencil and go slowly. You can use a rolled piece of tape or blue tack to keep the shape in place while you trace. [congruency]
11. Repeat steps 9 and 10 for every fold line on the paper. You will trace the shape eight times when done. [patterns, angles]
12. Remove the heavy card tracer and paperclip.

13. Think about your design and decide what colour scheme and pattern you will use to colour your mandala. What pattern would work besides AB. [patterning]
14. Follow your pattern and colour in the different areas of the design. Tip: each outlined area should be a different colour from the other shapes around it.

Suggestions to help make a great piece of art

- a. Keep the heavy card tracer simple and less detailed at the pin end and more detailed at the arrow end
- b. Colour solidly and carefully so each area is consistent.
- c. Tracing a shape's edges with colour first will help you stay in the lines when colouring.
- d. Think about the direction you're colouring. The little colouring lines you make can affect the final look of the piece.
- e. Choose a colour scheme that creates a mood or carries a message. Using just blues can be calming or sad, just greens can be peaceful, red and green creates energy, green with yellow and orange creates an autumn feeling, etc.
- f. Use a variety of different shades and tones of each colour, such as bright red, medium red, dark red, pink, navy blue, baby blue, sky blue, cobalt blue so that you have more choices about the colours you use.

Troubleshooting common mistakes

The shapes created by the overlapping tracings are not congruent: review how to line up the arrow on the tracer with the fold line, make sure the folds are accurate

Traces sloppily, goes off the edge or moves the tracer as tracing: use some tape to help hold the tracer in place, sharpen the pencil, slow down and press gently

Colours incongruent sections and breaks the pattern: work together to identify one specific repeating shape and put a dot of colour in each instance of that shape to establish the rotating pattern. Once those shapes are coloured, do the same with other shapes.

Grade Adaptations for Arts Curriculum

G4

Colour:

- Monochromatic colour scheme:
 - use a monochromatic colour scheme to create a mandala that expresses a particular mood

- Colour emphasis through variations in intensity (e.g., subdued colours next to bright, intense colours):
 - make certain parts stand out by using bright colours that pop against dark colours
- Advancing colour:
 - create the illusion of depth by contrasting bright areas against pale areas of colour

Emphasis:

- Use of colour intensity, contrast in value, placement and size of shapes, and/or weight of line to create a particular focal point in the design: Isolate a specific part of the pattern and emphasize it to make it stand out over other parts.

G5

Colour:

- Complementary colours, hue:
 - use a complementary colour scheme (red/green, blue/orange, purple/yellow) to create a dynamic image that vibrates with colour.

G6

Colour:

- The colour wheel; tertiary colours:
 - use 6 repetitions of the template and colour the resulting pattern like a colour wheel, with the areas between primary and secondary colours filled in with tertiary colours (what you get when you mix blue and green, for example). This will require a protractor or set square to measure out 60° guide marks.

Extended Art Outcomes

Line:

- Contour lines (e.g., edges of objects):
 - trace the outlines of each shape adding more and more lines in a concentric pattern, like a dart board.
- Linear and curved hatching and cross-hatching that add a sense of depth to shape and form:
 - rather than colouring, fill each shape with a directional hatching pattern, rotate the design so the hatching is laid out the same in each area, creating rotational symmetry using direction or density.
- Lines that create the illusion of force or movement (e.g., wavy and wiggly lines used in op art):
 - add extra details that create a movement effect, such as blur lines coming off of one edge of a shape, or vines that extend out from the centre of the design to suggest an explosion.

Value:

- Mixing of shades; variations in value to create emphasis (contrast in value):
 - use light and dark colour to make some stand out against others or to emphasize specific rings of pattern.
- Gradations of value to create illusion of depth, shading:
 - colour the area of each shape darker at the point closest to the centre, use pale colours near the centre of the pattern and brighter colours on the outside edges.
- Shading that suggests volume; gradation:
 - put a highlight off centred in each large piece, and shade the edges so the sections look rounded and gem like.

Stylistic Adaptations

- * Colour only certain shapes to create negative space; erase outlines of others to create a less connected design.
- * Use thick outlines to emphasize the shapes
- * Fill shapes with patterns or motifs such as little flowers, or stars, or swirls
- * Cut holes in the tracer to add more detail in the tracings

Extended Math Outcomes

- Represent fractions using concrete materials and words:
 - use the language of fractions to discuss how the page is being divided when folded: Halves, quarters, eighths, sixths, etc.
- Relate the names of the benchmark angles to their measures in degrees (e.g., a right angle is 90° ; every fold line is 45° from the last)
 - experiment with folding squares to divide the paper up into a different number of angles and try to name the size of the angles; Divide the paper up into different partitions using a protractor and pencil (3 guides- 120° , 5 guides- 72° , 10 guides- 36° , etc.

Assessment

Use these criteria as the categories in a rubric.

Math component

- Uses clear visual patterns that work with the number of divisions. For eight lines, AB, AABB, and ABCD would work.
- Demonstrates an understanding of congruency by folding accurately and creating equal-sized shapes within the rotational pattern.
- Can identify the right angles and the half right angles in the folded paper.
- Can name the type of transformation used to make the pattern.

Art component

- Used the tracer correctly to create very congruent shapes in the rotational pattern.
- Used a specific colour scheme to create a specific mood or convey a specific idea.
- Used a variety of colours or variations of a colour to create a colour pattern.

If all these components are met in a basic but accurate way, the artwork receives a B.

Sloppy tracing, messy colouring, incongruent pattern shapes, a faulty colour pattern or no pattern at all reduce the mark.

Clear evidence of planning a colour scheme, clean colouring process, and flawless tracing and alignment of pieces will increase the mark.