

Math in Science: River Fractals



MAIN IDEA

Discover the beauty and simplicity of naturally occurring branching fractals by creating your own paper watershed model.

SCIENCE BACKGROUND

Fractals form through the never-ending repetition of simple mathematical patterns and rules. Fractals exist in nature, in geometric figures, and in images created by mathematical algorithms. Fractals are all around us in our everyday lives, such as the branching patterns of trees and lightning, the spiral patterns of galaxies and hurricanes, and even hidden in your favorite animated movies!

Fractal branching is one category of fractal patterns and they form when a line separates and branches off over and over again, each split making smaller and smaller yet more and more branching lines. In nature, fractal branching's purpose is to optimize efficiency. For example, the fractal branching of our lungs allows us to maximize the intake of oxygen. Even ants create fractal branching patterns in anthills, forming complicated vast networks within a small space.

Fractal branching in watersheds and rivers maximizes the transportation of water and minerals throughout the land towards the sea. Analyzing fractal patterns in natural landscapes, especially in the river patterns of our watersheds, can help scientists understand these vast mathematical structures and their purposes in the natural world.



MATERIALS

White cardstock or heavy paper preferred (*or stack a few sheets of regular printer paper*)

Marker

Pencil

Spray bottle filled with water

Optional: pipe cleaners

ACTIVITY PROCEDURE

Step 1: Lightly crumple up your sheet of cardstock or heavy paper, just enough to create ridges and valleys, and then uncrumple it, making sure the ridges and valleys are still noticeable.

Step 2: Draw a line on the ridges of the paper (tops of the mountains) with a marker.

Step 3: With a spray bottle on a mist setting, spray the paper a few times, just so that the ink lightly bleeds and starts to branch down your ridges to your valley like a river.

Step 4: Observe what happened with the branching of the water and try to map it out by drawing the pattern of one of your rivers on a separate piece of paper.

Optional:

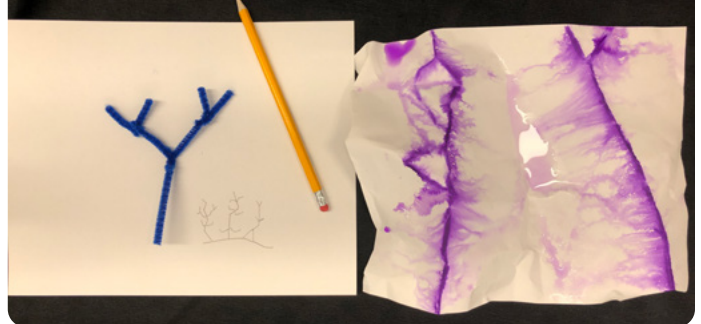
Use pipe cleaners to create a 3D model. Do you notice any repeating patterns?

Step 5: Now you can create your own fractal, starting with a simple pattern, and repeating it again and again on smaller scales. What shapes and angles does your pattern create?

STEP 2



STEP 4



EDUCATIONAL STANDARDS

Grade 4

Big Idea 1: Geometry

MAFS.4.G.1.1- Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.

Big Idea 3: Operations and Algebraic Thinking

MAFS.4.OA.3.5- Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself.

Grade 6

Big Idea 6: Earth and Space Science

SC.6.E.6.2- Recognize that there are a variety of different landforms on Earth's surface such as coastlines, dunes, rivers, mountains, glaciers, deltas, and lakes and relate these landforms as they apply to Florida.

Grades 9-12

Big Idea 1: Geometry: Modeling with Geometry

MAFS.912.G-MG.1.3- Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).

ADDITIONAL RESOURCES

What is a Fractal?

<https://www.youtube.com/watch?v=WFtTdf3I6Ug>

Diving into the Mysteries of Fractals

<https://www.discovermagazine.com/the-sciences/fractals>

Fractals in Nature

<https://cosmosmagazine.com/mathematics/fractals-in-nature>

Lake Nasser Fractal Branching

<https://earthobservatory.nasa.gov/images/5988/lake-nasser-egypt>

Mandelbrot Zoom

<https://www.youtube.com/watch?v=PD2XgQOyCCk&feature=youtu.be>

How Mandelbrot's Fractal Changed the World

<https://www.bbc.com/news/magazine-11564766>

Fractals: World of Mathematics

<https://mathigon.org/world/Fractals>

