**Unit 1: Investigation 5 (2 Days)**

**Patterns with Fractals**

***CCSS: F-IF 3, F-BF 1, F-BF 2***

**Overview**

Students explore geometric patterns of fractal designs. Students create pictures of fractals and use tables to represent patterns in fractals.

**Assessment Activities**

**Evidence of Success: What Will Students Be Able to Do?**

Create fractals, identify patterns in fractals, and write recursive rules for geometric sequences.

**Assessment Strategies: How Will They Show What They Know?**

**Exit Slip 1.5** asks students to identify a fractal pattern and use the pattern make predictions.

**Journal Entry** prompts students to define self-similarity in their own words and identify fractals in the real world.

**Launch Notes**

Discuss the presence of fractals throughout the natural world by showing images of fractals in nature. Explain that fractals are around us in nature and are used to represent views on the cosmos and the universe. Some websites that show fractals and images in nature are <http://www.alicekelley.com/>, <http://www.splashnology.com/article/60-amazing-fractal-designs/393/>, and <http://www.incrediblesnaps.com/spiral-fractal-designs>.

**Closure Notes**

Conduct a group discussion asking students what they found most interesting about fractals.

**Teaching Strategies**

1. In **Activity 1.5.1 Fractal Geometry**, students are allowed to choose a fractal pattern out of a selection of 5 fractal patterns. Students create a fractal pattern and complete a table identifying the number of unshaded regions at each stage. Students are asked to find an explicit rule for the number of unshaded regions. Provide guiding questions or hints to elicit recognition of the explicit rules for each pattern. If students don’t see the relationship between the number of unshaded regions and the stage number, have students express the number of unshaded triangles using prime factors. For example, in Sierpinski’s Triangle (pattern 2), rather than expressing the number of unshaded regions in stage 2 as 9, express this number as $3×3$ or $3^{2}$. In this way, students will connect the number of factors in the expression to the stage number. Distribute colored markers or colored pencils for students to use on their designs.

**Differentiated Instruction (For Learners Needing More Help)**

In **Activity 1.5.1a Fractal Geometry**, the stage one pattern is already completed for every pattern.

**Group Activity**

Separate the class into five groups. Assign each group a different fractal design from **Activity 1.5.1 Fractal Geometry**. Each student in the group completes their own version of the group’s fractal design.

1. In **Activity 1.5.2 Sierpinski’s Triangle**, students explore patterns in Sierpinski’s triangle, one of the most famous fractals. Students examine the fraction of the original equilateral triangle which remains unshaded as the stage number increases, and the sum of the perimeters of the triangles added at each stage as the stage number increases. Students find recursive and explicit rules and use the rules to make predictions. You may need to provide guidance on how to find an explicit rule.

**Differentiated Instruction (Enrichment)**

**Activity 1.5.2 Sierpinski’s Triangle** allows students to explore the length of sides and perimeter of triangles at multiple stages of the fractal.

1. In **Activity 1.5.3 Koch Snowflake**, students explore a fractal which requires that they add images onto a figure rather than shading regions into a figure. Students find the recursive rule and explicit rule for the fractal pattern. You may need to provide guidance on how to find an explicit rule. Following the activity, ask students questions about the long term behavior of the pattern. “*Can we continue to divide the sides? Does this pattern continue forever? What happens to the length of each side at each stage?”* Questions such as these introduce the idea of limits and lay the foundation for future thought.

**Journal Prompt**

1. Explain what self-similarity means in your own words.
2. Where are fractals found in nature?

**Resources and Materials**

* **Activity 1.5.1 –** Fractal Geometry
* **Activity 1.5.1a –** Fractal Geometry
* **Activity 1.5.2 –** Sierpinski’s Triangle
* **Activity 1.5.3 –** Koch Snowflake
* **Exit Slip 1.5.1 –** Fractals
* Colored pencils