

Elementary (4th grade)

# THE FIBONACCI SEQUENCE IN NATURE

Are patterns consistent in nature and what is the connection between patterns in nature and the Fibonacci sequence?

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Standard Benchmarks and Values:

**Mathematics Common Core State Standards (CCSS):**

- Operations and algebraic thinking 4.OA - Generate and analyze patterns.
  - 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.
- Standard 9: Patterns, Functions, and Algebra: Patterns and Functional Relationships: Understand various types of patterns and functional relationships.
  - Benchmark MA.4.9.1 Extend, create, and generalize growing and shrinking numeric and geometric patterns (including multiplication patterns).



### Enduring Understandings:

1. Be able to recognize and identify the occurrence of the Fibonacci sequence in nature.
2. Be able to recognize reoccurring patterns in plant growth and nature.
3. Be able to observe and recognize other areas where the Fibonacci sequence may occur.

### Background/Historical Context:

The Fibonacci sequence is named after its discoverer Leonardo Pisano Bogollo, who was a famous Italian mathematician otherwise known as Fibonacci. The Fibonacci numbers were first discussed in a book Bogollo published in 1202 titled *Liber Abaci*, where he described the growth of a population of rabbits under specific conditions. The conditions stated that a pair of rabbits were needed to breed and each pair of rabbits must mature two months before breeding more rabbits, where they were then expected to produce a litter of one male and female rabbit. Under these conditions it was observed that to find the total number of rabbit pairs you have for each month, you add together the number of pairs that were alive in the preceding two months – this pattern followed the series of numbers in the Fibonacci sequence (Fractal Foundation, 2013). The first

two numbers in the Fibonacci sequence are 0 and 1, and each succeeding number equates to the sum of the previous two numbers. There are infinitely many Fibonacci numbers that exist and these numbers can be found everywhere in the world around us.

Nature is all about math. If you were to observe the way a plant grows new leaves, stems, and petals, you would notice that it grows in a pattern following the Fibonacci sequence. Plants do not realize that their growth follows this sequence. Rather, plants grow in the most efficient way possible – new leaves and petals naturally grow in spaces between old leaves, but there is always enough room left for one more leaf or petal to grow.

Hawai'i is filled with various tropical plants and vibrant fruits that naturally grow following the Fibonacci sequence, such as the infamous pineapples from Dole Plantation and our state flower the Hawaiian hibiscus. If you were to count the number of scales a pineapple has on each of its spiral, or count the number of petals Hawai'i's state flower has, you would discover that it is a number in the Fibonacci sequence. The prevalent occurrence of the Fibonacci sequence in nature allows students to see and discover for themselves the presence of mathematics in the environment they live in.

## Authentic Performance Task:

As a class, students will complete their own Fibonacci table to complete the following assignments individually:

- Classify flowers that can be found in Hawai'i into a Fibonacci table according to the amount of petals the flower has.
- Create their own flower that exemplifies a number in the Fibonacci sequence.
- Students will complete a pre and post assessment about questions regarding the Fibonacci sequence to measure their learning.

As a class, students will complete their own Fibonacci table to complete the following assignments in small groups of 4 to 5 people:

- Recognize and identify the Fibonacci sequence's occurrence with pineapples.

## Authentic Audience:

The described activities are designed for elementary students in the fourth grade.

## Learning Plan:

1. Students will first complete a pre-assessment by answering questions regarding the Fibonacci sequence:
  - a. What are the first 10 numbers in the Fibonacci sequence?
  - b. How do you find out the next number in the sequence?
  - c. Name a plant or fruit that exhibits the Fibonacci sequence. Explain how or why it does.
2. Present a mini lecture about the Fibonacci sequence along with identifying the difference between flower petals and sepals (optional). Physically show students examples of flowers that exhibit the Fibonacci sequence.
3. As a class, students will then complete their own Fibonacci table to help them complete the other activities, which will be done individually and in small groups.
4. After the table is complete, students will complete the worksheets: "Fibonacci Flowers in Hawai'i" and "Fibonacci Flower":
  - a. "Fibonacci Flowers in Hawai'i" – In groups of 4 to 5, classify pictures of flowers that may be found in Hawai'i according to the number of petals.
    - b. "Fibonacci Flower" – Individually, students will create their own flower that exhibits the Fibonacci sequence using crafting supplies (scissors, glue, tissue paper, felt paper, pipe cleaners, etc.). Note: This activity could also be done around Mother's day for students to create a Fibonacci flower bouquet for their mom.
5. Reflect with students about the activities as a class, and have them share the flower they created with the class (optional).
6. In groups of 4 to 5, students will complete the activity: "Fibonacci Pineapple"
  - a. Count the amount of spirals of a pineapple by marking each spiral in every direction with colored tape.
7. Reflect with students about the activity and the lesson as a whole.
8. Students will complete a post-assessment by answering questions regarding the Fibonacci sequence (same questions as pre-assessment).
  - a. While students are completing their post-assessment, cut the pineapple chunks up for them to eat after completing their post-assessment (optional).

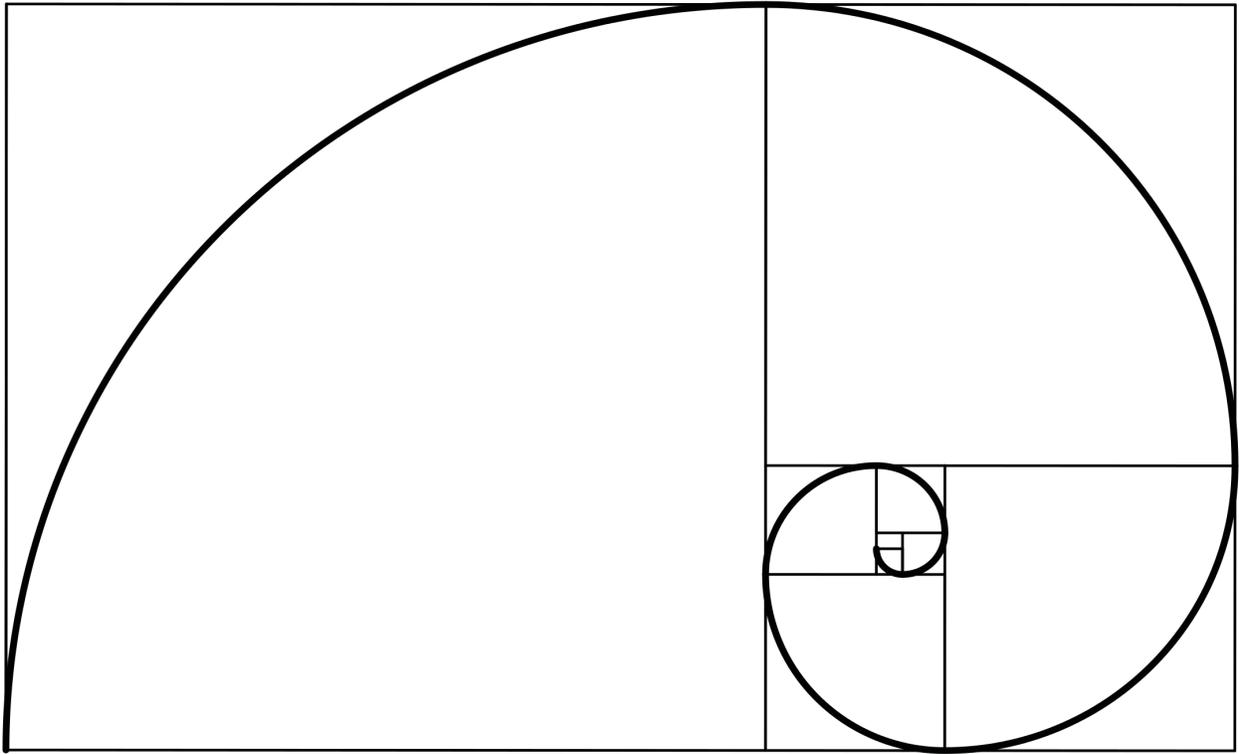
Standard Benchmarks, GLOs, or Nā Honua Maui Ola	Skills	Concepts	Assessment
<p><i>Operations and algebraic thinking 4.oa</i></p> <p>Generate and analyze patterns.</p> <p>Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself.</p>	<ul style="list-style-type: none"> <li>- Make observations</li> <li>- Recognize patterns</li> <li>- Classify objects</li> </ul>	<ul style="list-style-type: none"> <li>-Generating and analyzing patterns.</li> <li>- Classifying objects knowing similar properties or given a rule.</li> </ul>	<ul style="list-style-type: none"> <li>- Completing an art activity where students create a visual representation (flower) of a number in the Fibonacci sequence.</li> <li>- Working with a pineapple to observe the Fibonacci sequence's occurrence with the fruit.</li> <li>- Identifying and organizing flowers that exhibit the Fibonacci sequence based on the number of petals the flower has.</li> </ul>
<p><i>Standard 9: Patterns, Functions, and Algebra: Patterns and Functional Relationships: Understand various types of patterns and functional relationships.</i></p> <p>Benchmark MA.4.9.1</p> <p>Extend, create, and generalize growing and shrinking numeric and geometric patterns (including multiplication patterns)</p>	<ul style="list-style-type: none"> <li>-- Make observations to recognize patterns in a sequence.</li> <li>- Describe patterns.</li> <li>- Perform basic computations such as addition.</li> </ul>	<ul style="list-style-type: none"> <li>- Generating and analyzing patterns.</li> <li>- Extending the sequence following the recognized pattern.</li> </ul>	<ul style="list-style-type: none"> <li>- Completing a Fibonacci table up to the first 6 numbers in the sequence.</li> </ul>

## Conclusion

Hawai'i is filled with a wide collection of tropical fruits and plants that enhance the beauty of our environment while also supplying food for its inhabitants. By completing this lesson, students become more aware of the natural beauty that surrounds them and are motivated to learn about the importance of taking care of our 'aina to preserve our island's beauty.

## Appendix

Golden ratio for upper grade levels: Individually, students will complete an activity about the golden ratio. In the activity students will be measuring the angle between one flower petal to another using a protractor, and perform calculations to determine if the flower exhibits the golden ratio. After completing this portion of the activity, students will then calculate for the golden ration by computing the ratio of successive Fibonacci numbers.



Fibonacci Spiral

## References:

Fractal Foundation. (2013). Fibonacci Fractals. Retrieved from <http://fractalfoundation.org/OFC/OFC-11-1.html>

### 10 search terms:

1. Fibonacci sequence
2. Number pattern
3. Number of flower petals
4. Pineapples fruit scales
5. Golden ratio
6. Leonardo Pisano Bogollo
7. Analyzing patterns
8. Classification
9. Number sequence
10. Geometric patterns