Title: From Nature's Code to Artistic Spirals: The Fibonacci Sequence

Interest/Topic: math, art, biology

Materials Needed:

- Grid paper or a sketchbook
- Pencil and eraser
- Ruler
- Calculator
- Colored pencils, markers, or paints
- The Golden Spiral artwork from the previous lesson
- (Optional) Pictures of pinecones, sunflowers, or flowers with a clear number of petals

1. Learning Objectives

By the end of this lesson, Vienna will be able to:

- Define and generate the Fibonacci sequence.
- Explain the mathematical relationship between the Fibonacci sequence and the Golden Ratio.
- Construct a Fibonacci Spiral using squares based on the sequence.
- Create a piece of art inspired by natural patterns using the Fibonacci Spiral.

2. Alignment with Standards and Curriculum

This lesson builds on previous ratio work and deepens understanding of mathematical patterns:

- **Common Core Math Standard (6.EE.A.1, 6.EE.A.2):** Write and evaluate numerical expressions. This lesson involves generating and using a sequence, which is a foundational concept for algebraic thinking and functions.
- **Sequential Progression:** This lesson directly follows the study of the Golden Ratio. It introduces the Fibonacci sequence as a different path to the same famous proportion, moving from a single geometric ratio to a numeric pattern that generates it.

3. Instructional Strategies & Lesson Activities (Approx. 60 minutes)

Part 1: The Hook - The Secret Code in the Spiral (10 minutes)

- **Review and Connect:** Start by looking at the Golden Spiral artwork created in the last lesson. "Last time, we used a special number, the Golden Ratio (1.618), to create this beautiful spiral. We found it by dividing lengths. But what if I told you there’s a secret list of whole numbers that nature uses to grow, and this list has the Golden Ratio hidden inside it?"
- **Introduce Fibonacci:** "Hundreds of years ago, a mathematician named Fibonacci posed a puzzle about how fast rabbits could reproduce. The solution created one of the most famous number patterns in the world. Let's see if we can crack his code."

Part 2: Exploration - Generating Fibonacci's Code (15 minutes)

- **Guided Discovery:** "The sequence starts simply. Let's start with 1 and 1." Write them down. "To get the next number, you just add the two before it. So, what's 1 + 1?" (2). "Great. Now what's the next one?" (1 + 2 = 3). "And the next?" (2 + 3 = 5). Guide Vienna to generate the sequence: **1, 1, 2, 3, 5, 8, 13, 21, 34...**
- **The "Aha!" Moment:** "This is the Fibonacci sequence. It looks simple, but let's see what happens when we combine it with what we learned last time. Use your calculator. Divide one number in the sequence by the number that came just before it. Let's start further down the list for a better effect."
    - 8 ÷ 5 = ? (1.6)
    - 13 ÷ 8 = ? (1.625)
    - 21 ÷ 13 = ? (approx. 1.615)
    - 34 ÷ 21 = ? (approx. 1.619)
- **Connecting the Concepts:** "What do you notice? The further we go in Fibonacci's secret code, the closer the ratio gets to our old friend, the Golden Ratio! This sequence is nature's way of building with that 'perfect' proportion."

Part 3: Main Activity - Building the Fibonacci Spiral (25 minutes)

- **Step-by-Step Construction:** "Last time we made a spiral with one big rectangle. This time, we'll build one with a set of squares using our new number code. Grid paper will make this easy."
    1. In the center of the paper, draw a **1x1** square (1 unit on the grid paper).
    2. Right next to it, draw another **1x1** square.
    3. Above both of those, draw a **2x2** square. Its side will touch the top of both 1x1 squares.
    4. To the side of this block of squares, draw a **3x3** square.
    5. Below the entire group, draw a **5x5** square.
    6. Continue with an **8x8** square, and a **13x13** if you have room. Notice how each new square's side length is the next number in the sequence.
- **Drawing the Spiral:** "Just like last time, we'll draw an arc in each square. Start in the first 1x1 square and draw a quarter-circle arc connecting opposite corners. Continue the line into the next square, drawing another arc, and so on, spiraling outwards through bigger and bigger squares."
- **Creative Application:** "You've just created a Fibonacci Spiral! This pattern appears everywhere—from the way a fern frond uncurls to the shape of a hurricane. Your mission is to transform this mathematical skeleton into a piece of natural art. Is it a chameleon's tail, a seashell, or a blooming flower? Use your colors to bring the code of nature to life."

Part 4: Closure & Reflection (10 minutes)

- **Compare and Contrast:** Place the new Fibonacci artwork next to the Golden Ratio artwork from the previous lesson.
- **Discussion Questions:**
    - "They look almost identical! But how was the *process* of making them different?" (Using a sequence of whole numbers vs. multiplying by 1.618).
    - "Why do you think they end up looking so similar?" (Because the ratio of the Fibonacci numbers gets closer and closer to the Golden Ratio).
    - "Think about a pinecone. The little scales make spirals. If you counted the spirals going one way, and then the other, you'd likely find two back-to-back Fibonacci numbers, like 8 and 13. Where else could you look for this number code?"

4. Differentiation and Inclusivity

- **Support:** The use of grid paper is a key support for this activity. For a student struggling with the drawing, you can pre-draw the first few squares (1, 1, 2, 3) to get them started.
- **Challenge Extension:** Challenge Vienna to investigate another natural phenomenon where Fibonacci numbers appear, like the number of petals on different types of flowers (lilies have 3, buttercups have 5, delphiniums have 8). She could create a small, illustrated guide to "Fibonacci in the Garden."

5. Assessment Methods

- **Formative (During the Lesson):** Observe Vienna's ability to generate the sequence and perform the ratio calculations. Her verbal responses to questions connecting the sequence to the Golden Ratio will demonstrate her understanding.
- **Summative (End of Lesson):** The primary assessment is the completed Fibonacci Spiral artwork and Vienna's explanation of its construction. Success is measured by her ability to articulate how the Fibonacci numbers were used to create the squares and how that process is related to the Golden Ratio concept from the prior lesson.