Fibonacci Flowers

Grade/ Grade Band: 7th – 10th Grade	**Topic:** Fibonacci Numbers	**Lesson #__1__ in a series of __1__ lessons**

Brief Lesson Description: Students learn about Fibonacci numbers with the help of sunflowers

Performance Expectation(s):

- SWBAT determine the ratio of counter-clockwise spirals to clockwise spirals in sunflowers IOT further establish their knowledge of ratios
- SWBAT analyze the connection between the ratio of sunflower spirals and the Fibonacci sequence IOT enhance their ratio reasoning skills to solve mathematical problems
- SWBAT apply the golden ratio found in sunflowers to cell growth in other plants IOT use rate reasoning in different applications
- SWBAT determine the angle of new growth in sunflower seeds IOT further establish and apply their knowledge of circles and degrees

Specific Learning Outcomes:

- CCSS.MATH.CONTENT.6.RP.A.1 — Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities
- CCSS.MATH.CONTENT.6.RP.A.3 — Use ratio and rate reasoning to solve real-world and mathematical problems

Narrative / Background Information

Prior Student Knowledge:

- A circle contains 360°
- Plants produce energy from the sun via photosynthesis
- Ratios
- Math functions (addition, subtraction, multiplication, & division)

Science & Engineering Practices:	**Disciplinary Core Ideas:**	**Crosscutting Concepts:**
• **MS-LS1-5** – Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms	• **LS1** – From Molecules to Organisms: Structures and Processes • **LS2** – Ecosystems: Interactions, Energy, and Dynamics	• **Patterns** – Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them • **Structure & Function** – The way an object is shaped or structured determines many of its properties and functions

Possible Preconceptions/Misconceptions:

- Plants grow randomly/growth is unplanned
- The world around us cannot be broken down into patterns

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:

- "Why are plants important to life on Earth?"
  - Provide oxygen, food, stable ground, etc.
- "Can plants think? How about do math?"
  - Most, if not all, students will say no they cannot think nor do math
  - In fact, many plants use math (ex. Venus fly trap)
- "If plants do use math, how can we tell? Is there a type of mathematics that relies on visuals? How about shapes?"
  - Yes, use Geometry

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:

- *Provide images of Sunflowers* "Look at these sunflowers. They're great examples of how plants use math. Are there any observations you can make about them? (Shapes, patterns, etc.)
  - Yes, a spiral shape/pattern
- "I have a challenge for you all: figure out the ratio of counter-clockwise spirals (B) to clockwise spirals (A) on this worksheet" (distribute)
  - Distribute worksheet and allow students to work individually or in pairs
  - Informally assess student progress
- "As the sunflower grew and more seeds were made, what pattern did we discover? How about with the number of spirals – was there a pattern there?"
  - As the number grew larger and larger, a ratio of "1.618…" was achieved
  - Yes, the next number in the series was the sum of the previous two numbers

EXPLAIN: Concepts Explained and Vocabulary Defined:

- Introduction to Fibonacci
- "As you take any number is the series (B) and divide it by the previous number (A), you will always get closer and closer to 1.618… This is known as a golden ratio."
- "What we are doing today is known as applied mathematics."
- "Let's apply this to the shape of our sunflowers: a circle. A circle contains 360°. We can subtract 1 from 1.618 because if we do one full rotation, we return to our start point on the circle. However, if we multiply .618 by 360°, we obtain 222.5°."
- "In fact, the sunflower seeds, as well as most cells, grow in something close to this pattern. Nature is not perfect, so sometimes mistakes or something different can happen."

Vocabulary:

- **Fibonacci Numbers** — the numbers in the following integer sequence, called the **Fibonacci sequence**, and characterized by the fac every number after the first two is the sum of the two preceding ones
- **Golden Ratio** — the special number found by dividing a line into two parts so that the longer part divided by the smaller part equal to the whole length divided by the longer part
- **Photosynthesis** — the process by which green plants and some other organisms use sunlight to synthesize foods from carbon d and water
- **Applied Mathematics** — focuses on the creation and study of mathematical and computational tools broadly applicable in science an engineering, and on their use in solving challenging problems in these and related fields

ELABORATE: Applications and Extensions:

- "So we established how plants grow, but why do we care about this? What does the placement of cells have to do with growth?
  - Cell placement is important to the amount of sunlight a plant receives
- "Why do plants need sunlight? Furthermore, why does getting the maximum amount of sunlight affect growth?"
  - More sunlight = higher rate of photosynthesis

EVALUATE:

- Informal assessment based on: students asking questions, ability to answer questions, etc.

Formative Monitoring (Questioning / Discussion):

- Handout given, providing a student with a problem they must solve using ideas learned in the lesson
- Graded for points or completeness (by discretion of educator)

Summative Assessment (Quiz / Project / Report):

- Instructor may allow long-term project where students will be required to grow a sunflower and observe what they learned first-hand
- Project grading must require, but not be limited to: 1) scientific accuracy, 2) accuracy of calculations, and 3) explanation of connection between Fibonacci sequence and plant growth
- Other grading policies at discretion of instructor

Elaborate Further / Reflect:

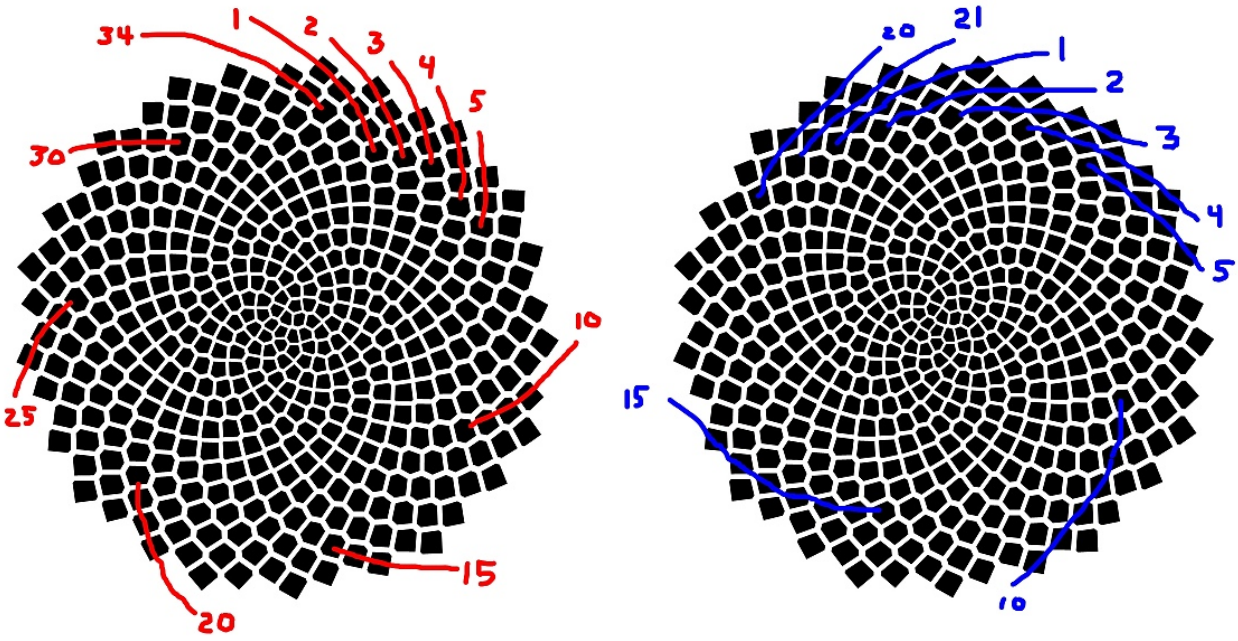
- Instructor may wish to discuss properties of efficiency in organisms, photosynthesis via chlorophyll in plants, or any other topic pertaining to plants; however, the focus of the lesson must be Fibonacci Numbers

Enrichment:

- http://www.greatmathsteachingideas.com/2012/08/23/sunflowers-are-actually-applied-mathematicians/
- https://www.mathsisfun.com/numbers/nature-golden-ratio-fibonacci.html

Name:_____ Date:_____

How Can We Determine Plant Growth?



Look at the pictures above. Notice the difference between how the blue and the red spirals are formed. Determine the ratio of counter-clockwise spirals (B) to clockwise spirals (A).

The ratio (three decimal places) of counter-clockwise spirals (B) to clockwise spirals (A) is _____.

These numbers are part of a series of numbers known as the _____.
When we do a ratio of a number in the series by the previous number in the series, we get closer and closer to _____. This is known as a _____.

What is the shape of our sunflower? _____
How many degrees (°) does it have? _____

If we multiply the new ratio, which is _____, by 360°, how many degrees do we get?

Name:_____ Date:_____

Fibonacci Flowers Worksheet

1. (A) This process produces the energy required for plants to grow:
   a) Respiration
   b) Sequencing
   c) Photosynthesis
   d) Eating

   (B) What **THREE** (3) resources are needed for this to occur?

   a)

   b)

   c)

2. (A) Geometry is a branch of mathematics concerned with shapes. The shape we were concerned with the majority of this lesson was:
   a) Oval
   b) Sphere
   c) Rectangle
   d) Circle

   (B) What was the purpose of using this shape? (Hint: the units we used were degrees)

3. Observe the dot patterns below.
   a) Of the three, which corresponds with the Fibonacci Sequence and the Golden Ratio? _____

   b) Why do plants grow this way?

   c) Is it efficient or inefficient?

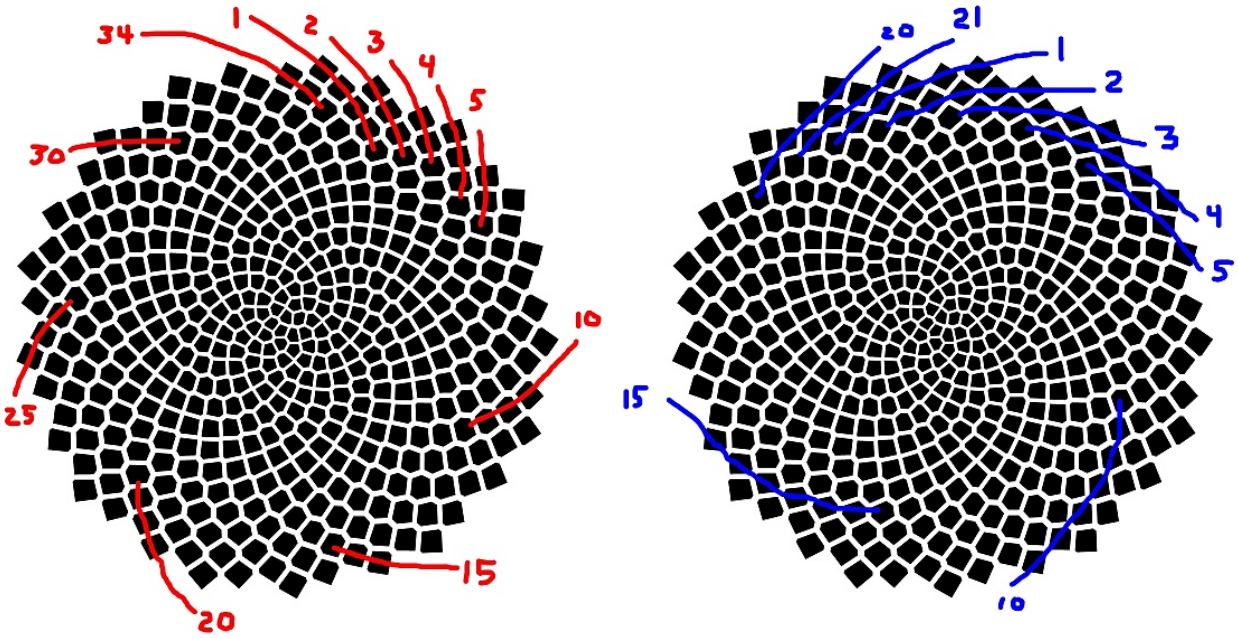
A

B

C

Name:_____ Date:_____

How Can We Determine Plant Growth? (Teacher Copy)



Look at the pictures above. Notice the difference between how the blue and the red spirals are formed. Determine the ratio of counter-clockwise spirals (B) to clockwise spirals (A).

$$\frac{B}{A} = \frac{34}{21} = 1.619\ldots$$

The ratio (three decimal places) of counter-clockwise spirals (B) to clockwise spirals (A) is___1.619…___.

These numbers are part of a series of numbers known as the ____Fibonacci Sequence_____. When we do a ratio of a number in the series by the previous number in the series, we get closer and closer to ___1.618…___. This is known as a _____Golden Ratio_____.

What is the shape of our sunflower? _____Circle_____
How many degrees (°) does it have? _____360°_____

If we multiply the new ratio, which is_____0.618_____, by 360°, how many degrees do we get?222.5°

Name:_____ Date:_____

Fibonacci Flowers Worksheet (Teacher Copy)

1. (A) This process produces the energy required for plants to grow:
   a) Respiration
   b) Sequencing
   c) Photosynthesis
   d) Eating

   (B) What **THREE** (3) resources are needed for this to occur?

   a) Sunlight

   b) Water

   c) Carbon Dioxide (or CO_2)

2. (A) Geometry is a branch of mathematics concerned with shapes. The shape we were concerned with the majority of this lesson was:
   a) Oval
   b) Sphere
   c) Rectangle
   d) Circle

   (B) What was the purpose of using this shape? (Hint: the units we used were degrees)
   - Sunflowers can be shown as one circle
   - Circles are made up of 360 degrees

3. Observe the dot patterns below.
   a) Of the three, which corresponds with the Fibonacci Sequence and the Golden Ratio? ___B___

   b) Why do plants grow this way?
   So more cells can receive sunlight and undergo Photosynthesis

   c) Is it efficient or inefficient?
   This is efficient because it reduces the space between cells

A

B

C