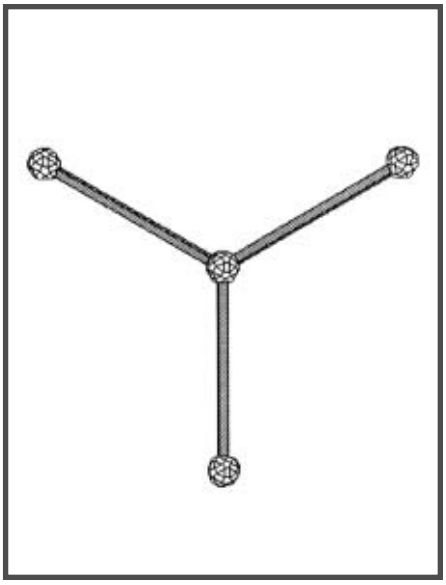
Zome System

Builds Genius!

Fun Fibonacci

Mathematics / Biology
Intermediate Concept

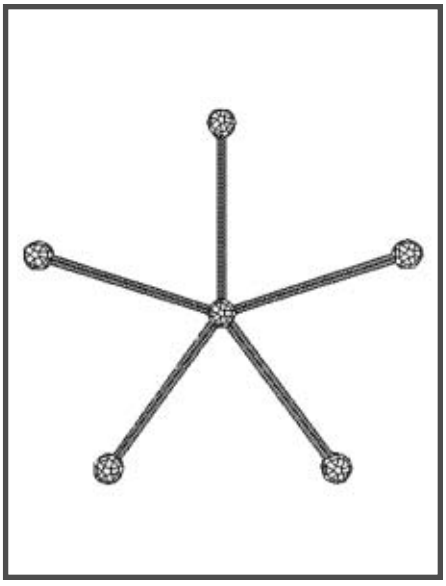


Lesson Objective:
Students will learn about Fibonacci numbers by discovering them in plant symmetries.

Prerequisite Skills:
Experience with symmetry lines in geometry and natural objects. ("What is Reflection Symmetry," "Multiple Reflection Symmetry," and "Rotational Symmetry").

Time Needed:
One class period of 45 to 60 minutes

Materials Needed:
- One Zome System Creator Kit
- Several pine cones
- One Pineapple
- One head of cauliflower
- One artichoke
- Sunflower-several different types and sizes
- Poster or other display of Fibonacci numbers in nature (see Resource section)



Procedure:
Divide class into teams of 3-4 students, and distribute the Zome System pieces. Have short review session on symmetry, Zome System geometry, and numbers in nature. *What are the three shapes shown on the Zome System node? What numbers do these shapes represent?* W*here do we find the numbers 2, 3, and 5 in nature? What symmetries do we find in plants?* If the class does not list them, some examples are 3-fold symmetry in green peppers, clovers, irises, bananas; 5-fold symmetry in apples, morning-glories and many types of flowers, and 2-fold symmetry in almonds and walnuts. Ask the students to build some simple polygons and show how many lines of symmetry they have.

Fun Fibonacci

Zome System

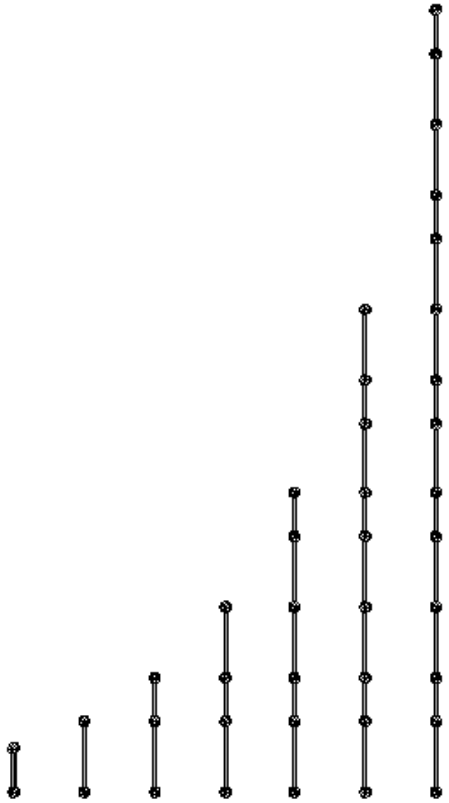
Builds Genius!

The question for the present class is if there are other numbers that can be found in natural objects. Distribute the fruit and vegetable examples among the students and allow them a couple minutes to try to determine where the numbers might be occurring. *If we begin looking at spirals in the plants, what might we see? Are the spirals clockwise or counterclockwise? How many clockwise spirals are on your particular botanical sample?* Have the teams make a chart on of type of sample, number of spirals clockwise, and number of spirals counter-clockwise. *How many counter-clockwise spirals are there?* Use caution not to double-count the first spiral. Use a pins or a marker to keep track of the starting point. *Are the spirals equal in both directions? Is one spiral tighter than the other?* Have the students list the number of spirals they found, in order. *What pattern emerges?* Give students time to discover the additive nature of the series.

Write the numbers 2, 3, 5 on the board. *How do these numbers relate to each other? How can the be used to make each other* (2+3=5)*? What is the next number in the sequence* (3+5=8)*?* Continue questioning until the class has derived the entire sequence: 1, 1 , 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233... *How do these numbers in the series compare to the numbers you found in the spirals of the botanical samples? Are there similarities?*

This series, know as the Fibonacci Sequence, was discovered in the late 12th century by the Italian mathematician Leonardo of Pisa, also known as Fibonacci. Although he was the first person to write down this series of numbers, he had no idea that these numbers occurred in plants.

If we take a look at the three lengths of one color in Zome System, we might see that this series appears here as well. *How do the three lengths of one color resemble the Fibonacci Series?* There are two connections. First, the short and medium struts joined together are exactly the same length as the long one. Second, each strut is larger than



the one before it by the same multiple.
Conclude the lesson by displaying additional manifestations of Fibonacci numbers in nature. Posters and various activity books can be used.

Assessment:
Review the tables created by the teams, as well as notes in individual math journals. To meet the standards, students must be able to show symmetry numbers in the botanical samples. To exceed the standards they must draw connections between the numbers in their tables and the Fibonacci sequence.

Standards Addressed:
* Mathematics standards addressing the development of number and number relationships (NCTM Standard 5).
* Mathematics standards addressing number systems and number theory (NCTM Standard 6).
* Mathematics standards addressing the exploration of patterns and function (NCTM Standard 8).
* Mathematics standards addressing the study of the geometry of one, two, and three dimensions in a variety of situations (NCTM Standard 12).

Transfer Possibilities:
More work on Fibonacci numbers and exploration of the Golden Section (page 10 in Zome System Manual, "Finding Tau," page 20 in Zome System Manual, and "Fibonacci Numbers and the Golden Section," "The Golden Thread - A History of Tau," pages 21-23 in Zome System Manual, and "Similarity and the Golden Section").

0 1 1 2 3 5 8 13 21
34 55 89 144 233 377
610 987 1597 2584....