"Fibonacci Sequence"

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This article introduces the Fibonacci Sequence, a series of numbers in which each successive number is calculated from the sum of the previous two (0, 1, 1, 2, 3, 5, 8, 13, 21; or $F_n = F_{n-2} + F_{n-1}$). From this sequence, we derive the Golden Ratio and the Golden Rectangle. In this lesson, students will experiment with the Fibonacci Sequence and study texts about God's role as the Architect of the world.

OBJECTIVES

- **Students will identify the Fibonacci Sequence in plants, fruits and vegetables, and architecture.**
- **Students will appreciate the greatness of God's Creation.**

VOCABULARY

מַדָּע	science
טֶבַע	nature
מָתֵמָטִיקָה	mathematics
פְּרִי	fruit
יָרָק	vegetable

FIND MORE ONLINE

On www.babaganewz.com/teachers, you'll find great teaching resources, including helpful hyperlinks to learn more about the Fibonacci Sequence.

QUOTES & QUESTIONS

"If you look closely enough, you'll find the Fibonacci Sequence everywhere—in nature, art, music, and Judaism."

What things does the article name as containing the Fibonacci Sequence?

Do you know any other things that also contain it?

Why do you think the Fibonacci Sequence is so common?

"Science teaches us to systematically investigate the underlying harmony in the world, and Judaism teaches us how to praise the Architect of that harmony."

Who do you think is the "Architect of harmony"? Why is this an appropriate name for God?

What do you think the "underlying harmony in the world" means?

How could investigating the world help us praise God?

The Torah tells us that God ordered the world in the process of Creation. Do you think that order is necessary for harmony?

ACTIVITY: FIND IT YOURSELF!

TEACHING TIP

Before class, familiarize yourself with the Fibonacci Sequence. Start by reading the article on page 9 of BabagaNewz and refer to the helpful hyperlinks on www.babaganewz.com/teachers for more information.

1. Read the article "Fibonacci Sequence" with your students on page 9 of BabagaNewz. Explain the Sequence, the Golden Ratio, and the Golden Rectangle.

2. Discuss the Quotes & Questions above.

TEACHING TIP

Distribute the observation worksheets available on www.babaganewz.com/teachers to help your students find these mathematical ideas in the real world.

Students will need paper, pencils, rulers, tape measures, and calculators for this activity.

3. Divide the class into three groups. Each group will examine different objects to find the Fibonacci Sequence.

IN YOURSELF

How many hands do you have?

On each hand, how many fingers do you have?

How many parts does each finger have?

How many knuckles on each finger?

Measure the length of the bones in each finger (slightly bend your finger to measure more easily).

What is the ratio between the longest bone and the middle bone? What is the ratio between the middle bone and the shortest bone? (Remember: a ratio is a comparison of two numbers, written as a fraction. The ratios will probably be close to 1.618, the Golden Ratio.)

Have students circle each number that is a Fibonacci number or Golden Ratio.

IN NATURE

Bring in an apple, lemon, grapefruit, banana, and several heads of cauliflower. Cut the apple, lemon, and grapefruit once across the middle (not lengthwise). Pass the fruit around the classroom for students to observe.

How many sections are in each piece of fruit?

Now hold up the banana.

Is the banana round? How many flat sides does it have?

Cut the banana in half across the middle. Peel one half and push your finger through the banana lengthwise (put your finger where the seeds are) to split the banana into three equal parts. Pass the other half around the room so students can observe these sections.

Now have students try to find the sequence themselves using the cauliflower.

Have students break into small groups and give each group a head of cauliflower.

Look at the cauliflower. How many different sections do you see? Look a little closer and try to find the center point, where the florets are the smallest. Can you see spirals around the head originating at this point? [A printable photo, available on www.babaganewz.com/teachers will help illustrate these spirals.]

How many spirals are in each direction? [Five in one direction and eight in the other direction.]

How many florets are in each spiral?

Have students break off a single floret. Each floret is a mini cauliflower with its own little florets arranged in spirals around its center.

How many spirals are in each direction?

How many florets are in each spiral?

Have students circle each number that is a Fibonacci number.

If time allows, have students go online to www.babaganewz.com (or even take a field trip outside) to find examples of the Fibonacci Sequence throughout nature—in flowers, leaves, seeds, and pinecones.

IN THE WORLD AROUND US

Look around the classroom (or *beit kenesset*) to find examples of the Golden Ratio.

Students can find the Golden Ratio in any of the following objects: 3"x 5" or 5"x 8" index cards, light switch plates, calculators, stamps, paperback novels, credit cards, playing cards, postcards, writing pads, and game boards. Make some of these objects available in your classroom and point students towards them.

What is the height of this object?

What is its length of this object?

What is the ratio of these two measurements—expressed as a fraction and decimal? Is this ratio a Golden Ratio?

Can you find a Jewish object in the room whose measurements are the Golden Ratio? (Try measuring a Siddur, tzedakah box, *Ḥumash*, or *aron kodesh*.)

4. Discuss the Jewish Text from Psalms 104:24 below.

5. Once students have uncovered examples of the Fibonacci Sequence, have them write a short journal entry to reflect on all their observations. Have students open their journal entry with the verse from Psalms.

How does your hand, the fruit, even the objects around the room, demonstrate God's wisdom in creating the world?

JEWISH TEXT

PSALMS 104:24

How great are Your works, God. You make them all with wisdom; the earth is full of Your possessions.

This psalm is recited on *Rosh Ḥodesh*, the celebration of a new month. Why do you think this is an appropriate time to say this psalm? Why is the idea that God created great things with wisdom important to remember at the start of a new month?

The Sforno (classical Jewish commentator) adds that "all with wisdom" means that nothing was created by chance, that God created the world with a master plan. How does the activity that we just completed demonstrate this idea?