FASCINATING FIBONACCI!

MASTER TEACHER Terri Salas

GRADES 7-9
MATH/SCIENCE

OVERVIEW

This math/science lesson is an interesting follow up after a math unit on arithmetic and geometric patterns and sequences in math. Other math concepts reinforced by the Fibonacci numbers are similar figures and proportions. The Fibonacci sequence stimulates exploration of patterns and sequences found in the real world. Fibonacci is the nickname for the Middle Ages (c.1200) mathematician Leonardo of Pisa who contributed much to algebra, arithmetic, and geometry. The sequence highlighted in the video is named after him and scientists have discovered that it occurs naturally in countless natural phenomenon. For example in this video, a math problem dealing with the reproduction cycles of rabbits, illustrates that patterns, such as the Fibonacci sequence, exist in nature. In turn, scientists may use these patterns to make predictions. The ratios made by comparing Fibonacci numbers are found in our body, harmony with music, architecture and engineering such as the design of a bicycle. The hands on activities allow the students an opportunity to practice and experience patterns, problem solving, and calculator skills as they find the missing numbers in the sequence. They may also apply the Fibonacci numbers to their bodies and environment via the golden triangle ratio. This lesson may be extended into other disciplines such as art or history and the hands on activities can easily become student projects.

KEDT EDUCATIONAL TELEVISION SERIES

Math Vantage: Sequence and Ratio (Episode #103)

MATERIALS

5 or 6 fresh pineapples
blank overhead transparency
overhead transparency pens (for teacher use)

(per student groups of 2 to 4)
4 sets of Multi-Links - two colors per group (100 pieces per color); any brand tiles or cubes such as unifix cubes may be used in place of the Multi Links

(per student)
meter sticks, centimeter rulers and/ or measuring tapes
worksheets "Busy Bees" and "The Rabbit Problem"
calculator (TI-Explorer)
pencil
2 sheets of notebook paper

VOCABULARY

Fibonacci	pattern
sequence	ratio
similar figures	genealogy
drone	spiral

LEARNING OBJECTIVES

The students will be able to:
*identify the Fibonacci sequence as being arithmetic, geometric or other
*write a short paragraph support their answer using appropriate math terms

PREVIEWING ACTIVITIES

If the cost is not prohibitive, have several pineapples available to pass around among the groups of students for examination. Ask the students to look at the pineapple from all sides and comment on any math ideas or patterns they may find in this fruit. (The students may notice that the eyes are six sided shapes (hexagons) or they may count the eyes themselves. They may also mention the spherical shape of the pineapple. Accept any answers and write them on the overhead transparency.) The students record the brainstorming answers on their

own sheet of paper. Tell the students that after watching the video the class will look at the brainstorming comments again, and compare their initial responses to the knowledge acquired in the video.

Optional: Another connection may be made to nicknames. Present several famous persons' names known to the students by first names or nicknames. For example, list personalities in current events like Madonna, Batman, Selena, Fabio, Pocahontas, etc. Again ask the students to state what these words have in common. (They may answer that the persons are all famous or that they appear in movies or TV.)

Tell them that all these persons are known by one name only or a nickname and that the mathematician to be highlighted on the video is also known today by a nickname, even though, he lived about eight hundred years ago. Tell the students that his name is connected with some math pattern that is found in many places in the natural and manufactured world. Challenge them to find math connections with this mathematician and the pineapple as they view the video.

FOCUS FOR VIEWING

To give the students a specific responsibility for viewing, tell the students to use their listening and note taking skills to identify the famous mathematician and the sequence or pattern found in nature. Remind the students that they may add notes to their brainstorming list as they watch the video.

VIEWING ACTIVITIES

Start the video after the credits with the scene of the rock group. Let the video run through the rabbit scene and the explanation of Fibonacci's name. The word "Fibonacci" will appear on the screen. **Pause** right after the word "Fibonacci" is taken off the video screen. Ask the students to tell in their own words what they learned about Fibonnaci. (Students may tell he lived 800 years ago or that he was the son of Bonnaci. Another response may be that he acquired his nickname from his friends calling him son of Bonnaci.) **Rewind** only a small segment if you want the students to hear the segment again to self check.

Resume the video telling the students to listen for the problem Fibonacci created. The narrator states the rabbit problem and the word "huh" appears on the screen. **Pause** shortly after the word "huh" disappears from the screen and the narrator

states the rabbit problem. Ask the student to restate Fibonacci's problem. (Fibonacci asked, "How many rabbits would you have at the end of each month if each pair of rabbits gave birth to another pair of rabbits and each pair of rabbits gave birth to another pair after they become two months old?") Since the question is complex, be prepared to replay the segment several times. Then take the opportunity to have students make predictions of the amount and record them on their notes. **Resume** the video and watch the rabbits multiply as the Fibonacci sequence is displayed on the screen. The teacher in the video is throwing pair after pair of rabbits on the hay. Her comments are "And on and on and on.....".

Pause as she says, "There is a patterns here." Instruct the students to use the calculators to compute the next unknown number in the sequence. Encourage them to write the pattern numbers already displayed on the screen and then problem solve for the next number. Facilitate the problem solving by walking among the groups to check for understanding and answer questions. Ask the students to rename the different types of patterns and their operations. (Arithmetic patterns use addition and subtraction, geometric patterns use multiplication and division while, "other" patterns use a combination of operations.)

Resume the tape so that the answer is displayed and the students may self check their answer. (The answer is "21".) **Pause** after the answer of "21" is displayed on the screen. Give the students time to state how the pattern works. (The previous two numbers are added to get the next number.) Allow time to compute the next four numbers. Ask, "What type of pattern is this?" (This pattern is an "other". The numbers being added keep changing.) Mention again if anyone wants to make changes on the brainstorming notes.

Resume as the teacher continues to explain that the Fibonacci pattern is found everywhere in the real world. **Pause** as she says, " The Fibonacci sequence can be found all over, even, in flowers." At this point, instruct the students to notate the examples from nature where the Fibonacci numbers are found along with the Fibonacci numbers. A T chart may serve this purpose well and it is also a problem solving tool for gathering and organizing information. (A sample is provided.)

Resume the video for recording of data about the Fibonacci examples. The students may record the numbers up to the segment with the pineapple. The Fibonacci numbers are illustrated on the screen with purple highlighting of the spiral in the pineapple. **Pause** when she says, "Fibonacci numbers are found in artichokes and pine cones, too." The frame shows her holding an artichoke and pine

cone. The class may spend some time checking the list of numbers and discussing the Fibonacci numbers occurrence in nature. The students may go back to the original brainstorming guesses and make a statement in their own words with their new knowledge of the Fibonacci numbers in the pineapple. (The hexagons in the pineapple make spirals of hexagons around the pineapple. When you count the spirals they make Fibonacci numbers. The numbers are 8,13,and 21. A key with the examples is provided.)

This is a good place to stop for the first day if time warrants it and, assign the hands on activity with the multi link blocks to illustrate the Fibonacci sequence.

Resume the video and let the students continue to record the numbers on the piano and then continue with the ratios of the golden triangle. The video will show similar rectangles with their ratios. Then she says, "I change the ratio to a decimal number that means the same thing." **Pause** when she says, "I divide the top number by the bottom number to find the decimal." Give the students enough time to use their calculators to divide the ratios and find the decimals. (The decimals are 8/5=1.6; 13/8=1.625; 21/13=1.615.) Tell the class that these Fibonacci ratio decimals have a special name known as the golden rectangles. Alert them to listen for this information in the next segment. Ask them to record the real world examples of the Fibonacci numbers now seen as "golden triangles". **Resume** the video showing all the examples of golden triangles. The students may continue to record the real world examples of Fibonacci numbers know as golden triangles. (The examples are included in the attached T chart.) **Stop** the video after the two basketball players illustrate the body ratios. The teacher will say, "Try it with a friend!" Allow time for the students to check answers on the T chart and ask questions about the Fibonacci numbers.

POSTVIEWING ACTIVITIES

(OPTION 1 on day one)

Assign the students to groups of 2 to 4 (preferably 2). The students are to model the Fibonacci sequence numbers as the amount of blocks allow. The colors should alternate so that the distinct numbers may be seen. This may be the model of the Fibonacci rabbit problem and the different colors stand for the different generations.

For example if the colors are Yellow and White the blocks should align like this:
W=White and Y= Yellow.

```
                Y
                Y
                Y
             W  Y
             W  Y
          Y  W  Y
       W  Y  W  Y
W  Y  W  Y  W  Y
 1 ,1,  2,  3,  5,  8,.....
```

The student will be able to build the Fibonacci pattern with the multi links and draw a visual model that illustrates what she or he build with the multi Links.
The student will then write a short paragraph to explain what type of pattern the Fibonacci numbers create and use math terms to explain the computations involved in finding the next missing number.

Close the lesson with a class discussion on why this pretend situation is not life like. (Other factors in the environment may bring the numbers down such as food webs, natural deaths,, diseases, etc.) The "Rabbit Problem" worksheet or "Busy Bee" may be assigned for homework for added practice.

(OPTION 2 to reinforce the ratios of the golden rectangles)

Have the students work in groups of two. They are to do what the characters in the video did. Take the measurement from the waist to the floor and compare to the measurement of the waist to the head. The students help each other in measuring and calculating the ratio. The answers should be close to the golden

ratio but not exact since measurement is an approximation and human beings come in all shapes and sizes. Assign the pair to find other golden rectangles on their bodies and in the room such as the door, the window, the rectangular chalkboard, a book, the calculator, etc. Students may share their findings on a class chart. Have the students then gather measurements of four items found in the home that illustrate the golden rectangle (examples are a bicycle , door, window, a bed, a table, etc.) The student must show the ratio, units used, and the division problem including the rounding of the decimals.

ACTION PLAN

The students may invite a local agriculture extension agent to bring samples of local vegetation and demonstrate the different growth patterns. Then the students bring in a small branch from a local tree and demonstrate the growth pattern (s) on that particular tree. The main branch and its subsequent branches are labeled with the Fibonacci numbers. These models may fill a Fibonacci bulletin board.

EXTENSIONS

a) Students dress up as Leonardo de Pisa and give biographical information about the mathematician or teach a lesson on the Fibonacci pattern.

b) A fruit and vegetable tempera print is created after the students examine different items for occurrence of the Fibonacci numbers. Examples: the bell pepper cut crosswise reveals three chambers; an apple cut horizontally has a five point star cross section; daisies have 13,21 or 34 petals and giant sunflowers have 89 to 144 spirals.

c) Explore sums of the Squares of the First *n Fibonacci numbers*
n
1: 1^2=1 =1X1
2: 1^2 + 1^2=2 =1X2
3: 1^2 + 1^2 + 2^2= 6 =2X3
4: 1^2 + 2^2 + 3^2=15 =3X5
5: 1^2 + 1^2 +2^2 + 3^2 + 5^2 = 40 =5X8

d) Use a calculator to help write the ratios of the Fibonacci numbers as decimals to the nearest thousandth. Find the real world examples of these ratios. Extend to the examples of the golden ratio (1.6).

e) Study the work of Sonya Kovalevsky (1850-1891) who was fascinated by infinite sequences.

f) A student project may be to teach another student how to compute arithmetic or geometric patterns on a calculator.

g) A student project may be a slide presentation of Fibonacci numbers found in nature.

h) Weather data may be recorded, organized and illustrated on a mathematical model to demonstrate patterns and their use in making predictions