Math and Children's Literature Assignment

The Rabbit Problem

Author: Emily Gravett

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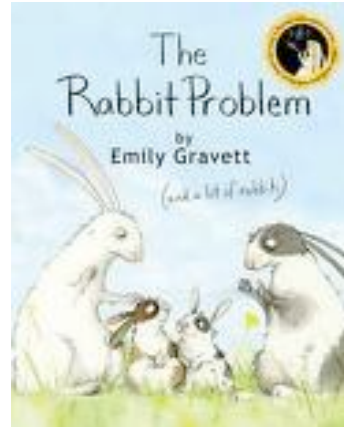
Language: English

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Grade Level: 1-5 (and beyond)

Rating: (4 carrots out of 5).

PART 1: SUMMARY

Plot/Theme: If a pair of baby rabbits are put into a field, how many pairs will there be:

a) At the end of each month?

b) After one year?

A family of rabbits soon supplies the answer in this funny story! Hop along to Fibonacci's Field and follow Lonely and Chalk Rabbit through a year as they try to cope with their quickly expanding brood. By March there's a pair of baby rabbits. By May there are five pairs, by July 13 pairs and by October there are 55. The final pop-up spread shows exactly what is meant by a rabbit problem.

Characters: Rabbits and more rabbits (and even more rabbits).

Setting: Fibonacci's field (A rural setting in England - a farmer's field).

About the Author: Emily Gravett is an author illustrator of unique talent and skill and has won both the Kate Greenaway Medal and the Nestlé Children's Book Prize Bronze Award twice. First, for WOLVES in 2005 and again for LITTLE MOUSE'S BIG BOOK OF FEARS in 2008. A former traveller, Emily has now settled in Brighton with her partner and their daughter.

Personal Connections: I have long delighted in Emily Gravett's books. Particularly, I have been drawn to her sense of humour and enchanting illustrations. I was first enraptured by The Rabbit Problem because of the incredible detail, whimsical humour and novelty elements in the book. What

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finally hooked me was the connection to Fibonacci's field. This is a storybook that has many layers. Although it first appears to be targeting primary readers the basis of the whole story is dependent on a complex number sequence first explored by a 13th century mathematician Leonardo of Pisa (who went by the pen name of Fibonacci). Gravett's cleverness is apparent in her metatextual presentation of Fibonacci's rabbits and surprisingly if you don't look closely enough (or know of Fibonacci's historical rabbit problem) you could even miss it. What I love about Gravett's work is that she manages to enchant adults and children in equal measure – and children of wide-ranging age, too.

The Mathematical Concept(s): Gravett explores many mathematical ideas in this book, including: counting, calendar math, temperature and measurement. All of these topics would be excellent fodder for a primary lesson. Gravett also provides a starting point for a class to explore number patterns in general and the Fibonacci sequence in particular.

Fibonacci first described his 'famous' number sequence as the solution to a math problem: If a pair of rabbits are put together under certain conditions ("NO Rabbits may leave the field"), how many will there be in one year? This puzzle, posed by Fibonacci in the 13th-century, is the premise for Gravett's book. Using lively illustrations Gravett explores one of the most unique number sequences of all times.

Fibonacci's Rabbits: Suppose a newly-born pair of rabbits, one male, one female, are put in a field. Rabbits are able to mate at the age of one month so that at the end of its second month a female can produce another pair of rabbits. Suppose that our rabbits never die and that the female always produces one new pair (one male, one female) every month from the second month on. The puzzle that Fibonacci posed was ...How many pairs will there be in one year?

Answer:

At the end of the first month, they mate, but there is still only 1 pair.

At the end of the second month the female produces a new pair, so now there are 2 pairs of rabbits in the field.

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At the end of the third month, the original female produces a second pair, making 3 pairs in all in the field.

At the end of the fourth month, the original female has produced yet another new pair, the female born two months ago produces her first pair also, making 5 pairs.

PHEW! A chart may help!
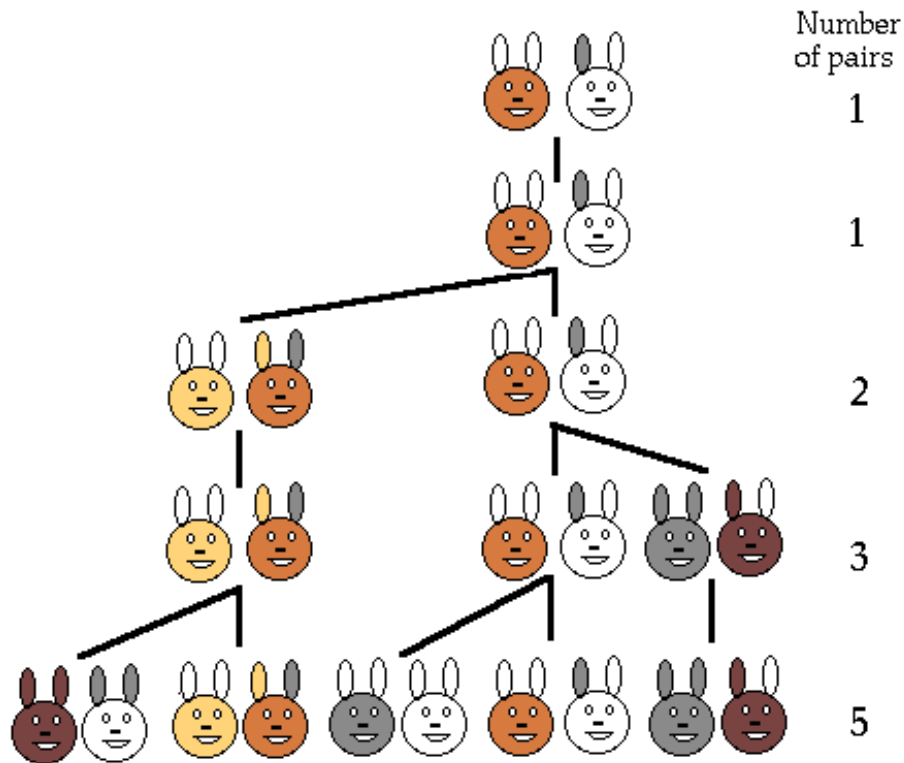
Eventually, the number of pairs of rabbits in the field are

1, 1, 2, 3, 5, 8, 13, 21, 34, ...

Can you see how the series is formed and how it continues? What pattern do you see?

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So what is the pattern? In the Fibonacci Sequence, each term is the sum of the two proceeding terms. For instance, 1 + 1 = 2, 2 + 3 = 5, 3 + 5 = 8.

In other words, the Fibonacci series is formed by starting with 0 and 1and then adding the latest two numbers to get the next one

  0, 1 The series starts like this.

    0+1=1 so the series is now

      0, 1 ,1

        1+1=2 so the series continues...

          0, 1, 1, 2 and the next term is

   1+2=3 so we now have

              0, 1, 1, 2 ,3 and it continues as follows ...

The first 12 numbers in the Fibonacci Sequence are

0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89 and 144.

Why Fibonacci Numbers? This number sequence is found everywhere in nature and has other real life applications too. The sequence may not be a law of nature but it is a fascinating prevalent tendency! In fact, these numbers come up many times in nature. Scientists who study plants have found that the Fibonacci numbers show up often in plants that have multiple parts (such as leaves, petals, or seeds) arranged around a single stem. A study found that two successive Fibonacci numbers appeared in more than 90% of such plants. The frequent appearance of Fibonacci numbers in nature has been a puzzle for a long time. Recently, scientists and mathematicians have been able to reproduce the patterns in laboratory studies and have offered new ideas about why the numbers arise.

When you chart Fibonacci numbers on a graph, you get the **Fibonacci spiral**. The swirl of **seashells**, ridges of **pinecones**, curve of animals' nails, centers of sunflowers, even human teeth curve in the Fibonacci spiral.
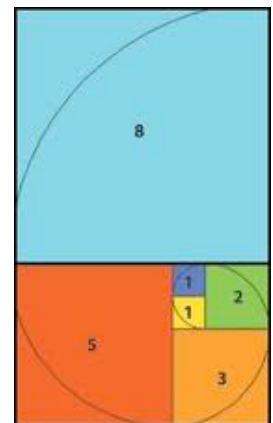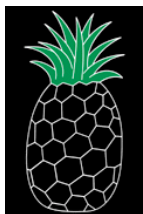
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Let's look at a pineapple.

Pineapple scales are also patterned into spirals and because they are roughly hexagonal in shape, three distinct sets of spirals may be observed.

One set of 5 spirals ascends at a shallow angle to the right,

a second set of 8 spirals ascends more steeply to the left

and the third set of 13 spirals ascends very steeply to the right.

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PART 2: Critique

Accuracy/Mathematical Integrity: Gravett's presentation of Fibonacci's Rabbit Problem and the subsequent sequence is accurate. She provides help for the viewer by providing a sign at the top of each page to indicate the number of rabbits each month. The tone of this book is exceptionally light and playful. All in all, Gravett presents Fibonacci's Rabbit Problem in an approachable and entertaining manner.

Visual and Verbal Appeal: Gravett is known for her illustrations. Her whimsical drawings are beautifully rendered in graceful watercolor and ink. There is so much going on for children to explore. Particularly of note is her book within a book conceptualization. As always, Gravett's design choices are perfect for enhancing the narrative. Viewers can turn the book lengthwise and watch the effects of the ever-multiplying bunnies in watercolor scenes on the top, while the hand-notes and novelty items glued to the dates below reveal seasonal challenges. In March, while the stressed parents learn infant care, a baby book showcases a tiny ultrasound of the twins. July depicts bored bunnies watching carrots grow. A miniature newspaper (The Fibber) includes biographical information on the famous mathematician, personals, birth announcements, graphs, and horoscopes. Under an empty, snow-covered field and through the die-cut hole that follows December 31, a peek and a page turn reveal the population explosion leaping, literally, off the page in a sturdy pop-up spread.

Connections: This book works on so many different levels. On one level it contextualizes everyday math concepts: calendar math, temperature, measurement etc. On another level, it recreates a math problem and number sequence dating back to the 13th century. To help her audience Gravett even provides information about Fibonacci in one of the smaller books enclosed within the main story. Gravett does a clever job of creating an enchanting story that
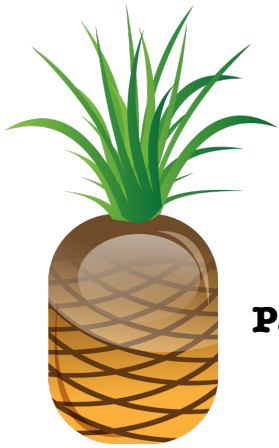
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readers can connect with. Who knew a 13th century number sequence could be so much fun?

Audience/Potential for Varied Response: This hilarious (and accurate) tale can be enjoyed by the numerically challenged and the gifted alike. Readers needn't care about the math of Fibonacci Numbers to love the hilarious, jam-packed visual details, many of which are playfully metatextual. If provides endless fun to pore over for kids and math-minded or geeky adults. Gravett's book while seemingly geared towards a primary audience also appeals to a more mathematically advanced group. It certainly allows children the opportunity to deduce many mathematical elements. What I like about this book is that it could be used in multiple classrooms. I would even use this in the upper grades as an entertaining way to introduce students to the Fibonacci's number sequence. I would then extend the lesson and explore the Fibonacci sequence in nature using authentic items (shells, flowers, fruit etc). I would even have older students pick a mathematical concept and create their own picture book mock up.

Ethnic, gender and cultural inclusiveness: The main characters in the book are rabbits. Male and female rabbits are represented equally. The book is set in a pastoral setting so for some audiences discussing the cultural context of an English country setting - garden/farm (aka Beatrix Potter) would be wise. There is evidence of stereotyping, the author does depict rabbits as being quite gregarious breeders but for this storyline it works :)

"Wow" Factor: This extraordinary picture book is packed with gorgeous details and novelty elements including a baby rabbit record book, a carrot recipe book and a surprise pop-up ending. The Rabbit Problem is brilliantly packaged. Laid out in a calendar format, the pages provide a clever backdrop for the story of a rabbit named Lonely, who sends out invitations in January looking for a friend. Gravett's 'tongue and cheek' portrayal of Fibonacci's problem makes this book a worthwhile read for all ages.

Criticisms: A couple of very small ones. To be unnecessarily pedantic, it ignores the issue of dying rabbits from the calculations of Fibonacci numbers. But then Fibonacci's Rabbit Problem is hypothetical and we all know that rabbits do not breed this way. Aesthetically, it's perfect, and bears looking at time and again. Still, I would have liked a slightly stronger narrative, to give it a bit more depth - perhaps another edition of the newspaper, or a rabbit's diary may have helped. One other suggestion would be for Gravett to make the connections of Fibonacci's sequence to nature more explicit.   Creating rabbits that were in a field of sunflowers, picking nautilus shells off a beach or eating a pineapple would add yet another intriguing layer.

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Part 3: Lesson Plan

Fibonacci Fruit (and Veggies)

GRADES: 6   **STRAND:** Patterning and Algebra

BIG IDEAS:

- To have students learn about the Fibonacci number sequence and its many real life applications.

- To reinforce students' knowledge of how number patterns work.

- To have students identify, build and extend number sequencing.

CURRICULUM EXPECTATIONS

Math

- Identify geometric patterns, through investigation using concrete materials or drawings, and represent them numerically

- Describe pattern rules (in words) that generate patterns by adding or subtracting a constant, or multiplying or dividing by a constant, to get the next term (e.g., for 1, 3, 5, 7, 9, ..., the pattern rule is "start with 1 and add 2 to each term to get the next term"), then distinguish such pattern rules from pattern rules, given in words, that describe the general term by referring to the term number (e.g., for 2, 4, 6, 8, ..., the pattern rule for the general term is "double the term number");

Science: Biodiversity

- Use scientific inquiry/research skills to compare the characteristics of organisms within the plant or animal kingdoms (e.g., compare the characteristics of a fish and a mammal, of coniferous and deciduous trees, of ferns and flowering plants)

- Investigate the characteristics of living things, and classify diverse organisms according to specific characteristics.

Prior Teaching

Students have already done some work with number sequences and patterns. They have identified and extended sequences and figured out rules/

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generalizations that explain how these sequences work. They have created their own sequences using tables, t-charts, and pictures/drawings to represent them.

Materials and Preparation

Real-life objects all showing Fibonacci numbers will be used for this lesson:

• bananas (sliced horizontally to reveal the seeds)

• pineapples

• apples (sliced vertically)

• grapefruit (cut in half)

• the florets in the spiral of a cauliflower

• broccoli florets

Pattern observation sheets

GETTING STARTED   **INSTRUCTIONAL GROUPING: Whole Class**

I would engage the students by holding up a pineapple and asking the question, "What do you think a pineapple has to do with a number sequence?" I would field several guesses first then guide the students by looking at some different number sequences that we have previously explored. We would talk about significant features of the numbers in these sequences, how they are formed, and the rule or generalization on which the sequence is based that makes them a pattern. I then say, "Today we are going to investigate a very important number sequence called the Fibonacci number sequence." I will introduce the students to who Fibonacci was, his importance in the field of mathematics, and that the sequence he 'discovered,' although mathematical, has many real-life applications. For example, the Fibonacci numbers can be seen everywhere in nature.

WORKING ON IT   **INSTRUCTIONAL GROUPING: Small Groups of 4**

Students will work in small heterogenous groups so children with different abilities can work together. For this activity, each student will have a particular role/job assigned before starting the activity. There will be four students per group and each student will be assigned one of the following roles: Materials Manager, Recorder, Presenter and Time Keeper.

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While working in their groups students will assume the roles that they have been assigned and examine the objects on their tables. Each recorder fills in the group's pattern observation sheet. The pattern observation chart looks like this:

Object	Illustration	Number of Sections or Spirals

While examining the many objects laid out at each group table the students are to consider the way in which the seeds are arranged in each of the fruits, the arrangement of the spiral on the pineapple, cauliflower and broccoli etc. They are to spend time investigating the objects while trying to determine their similarities and the requisite number pattern.

REFLECTING/CONNECTING   INSTRUCTIONAL GROUPING: Whole Class

After the pattern observation sheets are completed the class meets as a whole to discuss their findings and attempt to figure out the Fibonacci sequence. I will use the following questions to guide the class:

- Can you tell us about some of the things you found out or noticed in the objects you examined?

- What did you notice about the numbers that seemed to come up when you counted the seeds, and spirals?

- Do you have any theories about why these particular numbers kept appearing? If so, what are they?

- If these numbers are all a part of the Fibonacci sequence, what do you think the sequence is?

- How are the numbers determined?

Through class discussion I will have a student who has figured out the pattern act as an expert and post the solution on the board for all to see.

DIFFERENTIATION

This lesson can accommodate the unique needs of every student. Providing enhancement for students who need an extra challenge as well as supporting students who may need assistance. It also provide students a chance to use

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manipulatives to represent number sequences they will be exploring. Also, the open-ended nature of this lesson allows students the ability to work at their own pace.

ASSESSMENT

Gather anecdotal evidence to: Discern whether each students is able to make the connection between his/her observations and subsequent findings with the Fibonacci sequence?

Give a mini quiz (low stakes) at the beginning of the next class to see if the students can identify and extend the Fibonacci sequence? For example, is the student able to figure out the next number 3, 5, 8, 13, ____ ?

HOME CONNECTIONS

One possible topic to examine is the connection between the Fibonacci sequence with our teeth.

This lesson was based on an activity from Van de Walle's Elementary and middle school mathematics: Teaching developmentally (2005).

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RESOURCES

About the author:

Emily Gravett's official website:

http://www.emilygravett.com/

Watch Emily Gravett create a page from this book

http://www.youtube.com/watch?
v=PzNWl3lL9hg&feature=related

What is the fibonacci sequence?:

http://en.wikipedia.org/wiki/Fibonacci_number#In_nature

Two great sites on Fibonacci Numbers and Nature:

http://www.maths.surrey.ac.uk/hosted-sites/R.Knott/Fibonacci/fibnat.html#bees

http://britton.disted.camosun.bc.ca/fibslide/jbfibslide.htm

Other great children's books about the fibonacci number sequence:

Campbell, Sarah. (2010). Growing Patterns: Fibonacci

Numbers in Nature. Pennsylvania: Boyds Mill Press.

Hulme, Joy. (2005) Wild Fibonacci: Nature's Secret Code

Revealed. Berkeley: Tricycle Press.

Math Help

Van de Walle, J.A. (2006). Teaching Student-Centered

Mathematics. Boston: Pearson.