

Fibonacci Fun: Spirals in Nature

Chelsea Williams

3rd grade

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Section 2 Rational:

Fibonacci's numbers are found throughout nature, from the spiral of a ram's horn to the placement of seeds on a sunflower. Understanding this sequence provides students the opportunity to explore how it helps many different plants and animals reproduce, protect themselves and gather food within their natural environments. This unit introduces the famous math mathematician Leonardo da Pisa who published a book in 1202 called *Liber Abaci*. In his book, Leonardo explained how this sequence was represented in nature along with the importance of it in the reproduction and survival patterns of organisms. The concept "nature generates patterns" will allow students to identify the connection between math and biology. Students will recognize that these patterns help organisms reproduce and survive within their environment.

This unit will provide students with the essential background knowledge needed to begin to grasp advanced reproduction patterns of plants along with the characteristics of animals that help them hunt, reproduce and defend themselves in their natural environment. Students will be able to identify Fibonacci's sequence in their own back yard within pinecones, flowers and small mammals.

Gifted learners are unique in their curiosity and desire to explore and research different topics in-depth independent of teacher or parent request. These students are often intrinsically motivated and driven to learn as much as possible on concepts that interest them. These students often bore easily in traditional classrooms and require the opportunity to delve deeper into the content that is presented to them.

The materials presented provide students an opportunity to explore Fibonacci's sequence and begin to develop a deeper understanding of how these patterns are found throughout nature. The connection between Fibonacci's sequence and the patterns created by it throughout nature is not a topic traditionally covered by the general education elementary curriculum. This unit is intended for students that possess a higher verbal ability and features above grade level text and student facilitated discussions that will allow students to make generalizations based on the content.

The unit consists of four lessons specially designed for the needs of gifted learners. The first lesson will allow students to learn about the life of Fibonacci through a team-based learning activity, followed by an activity that requires them to apply the concepts to the reproduction patterns of bees. The second lesson introduces students to how Fibonacci's spirals are found in nature through visual thinking strategies and presents students' the opportunity to brainstorm where in nature they might draw their own inspiration. The third lesson familiarizes students with the art of the disciple of an artist who creates large murals through a Burner model. Students practice creating a Fibonacci spiral to scale and affords time for them to transform these spirals into an element of nature. The final lesson teaches students the varying levels of questioning through Costa's levels of inquiry and requires them to begin to develop higher-order questioning techniques.

After identifying how Fibonacci's sequence is represented in nature, students will begin creating a mural that features how this pattern is generated throughout the natural world. The teacher presents the performance tasks that will require students to develop a cohesive mural that represents how nature generates patterns. Students will create their own interpretation of

how that spiral is found in nature and collaborate with their teams to represent their ideas as a whole.

Throughout this unit, students will facilitate discussions at higher levels with limited teacher facilitation. They will consider different perspectives through discussion and inferences while articulating their opinions citing evidence from the text. The majority of the activities allow students the opportunity to conduct independent and group research on the topic and share their findings with their classmates.

This unit was designed for upper elementary students who have demonstrated not only intellectual curiosity but the ability to demonstrate complex thinking while covering content at an accelerated rate. These students should show a genuine interest in understanding the complex workings of the world around them as well as a desire to question the materials presented. These students must be able to conduct independent studies on areas of the curriculum and be able to create a final product that is representative of the content provided. This unit is best presented to students who have shown an interest in art and an understanding of upper elementary math concepts. While the unit could be modified for middle and high school students, it is intended for students between the ages of 8-12 years of age.

This unit is not limited to one culture or socioeconomic background but should instead be introduced after students have received some exposure to the reproductive patterns of plants and the features and functions of animals' claws, teeth, talons, and beaks. Students should have prior knowledge on how to find the area and perimeter of shapes as well as the ability to recreate a grid to scale. Students should have a mastery of addition and subtraction

up to 3 digits as well as the ability to multiply 2 digit numbers. This unit can be used as an opportunity to facilitate cooperation and time management through group work and classroom discussions. After completing this unit students should feel confident expressing their opinions amongst their peers and be able to support their ideas with facts from the materials.

Section 3 Goals and Outcomes:

This cross-curricular unit utilizes math, science, language arts, and visual arts standards 3rd grade North Carolina Content Standards

CONTENT GOALS AND OUTCOMES GOAL 1: Identify how the Fibonacci sequence is represented throughout nature

Students will be able to...

- A. Analyze a text to identify the main topics and retell key details of a text.
- B. Describe where Fibonacci's sequence is found in nature
- C. Understand how to use information learned in other disciplines, such as math, science, language arts, social studies, and other arts in visual arts.
- D. Apply creative and critical thinking skills to artistic expression

(From: [K-12 Standards, Curriculum and Instruction - NC Public Schools](#))

PROCESS GOALS AND OUTCOMES GOAL 2: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly.

Students will be able to...

- A. Answer who and what, where, questions to demonstrate an understanding of details in a text.
- B. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.
- C. Follow agreed-upon rules for discussions.
- D. Ask questions to check for understanding of information presented, stay on topic, and link their comments to the remarks of others.
- E. Explain their own ideas and understanding in light of the discussion.
- F. Access, organize and synthesize information
- G. Make inferences based on evidence.

(From: [K-12 Standards, Curriculum and Instruction - NC Public Schools](#))

CONCEPT GOALS AND OUTCOMES GOAL 3: To understand the concept of nature generates patterns

Students will be able to...

- A. Identify where Fibonacci's sequence is represented in nature
- B. Analyze how these patterns help plants and animals survive in their environment
- C. Understand characteristics of the Elements of Art, including lines, shapes, colors, form, space, and value
- D. Transfer their knowledge about systems to a newly encountered system

(From: [K-12 Standards, Curriculum and Instruction - NC Public Schools](#))

Section 4: Assessment Plan

Formative Assessments:

TBL Assessment: Blockhead- The life of Fibonacci

When students have finished listening to the read-aloud they will be given a 10 question quiz via google forms bit.ly/blockhead112358. Students will be instructed to complete the quiz independently. When students have completed the assessment the teacher will group students in their Team-Based Learning teams. The teacher will direct the students to review their answers with their team members and come to a consensus on their responses to their quiz questions. Once a consensus is reached the teacher will have the team participate in a Quizizz. If a student response is incorrect, the team must revisit the question utilizing the text for evidence to support their opinion and come to a revised response. This will continue until the group has found the correct response.

Block Head the Life of Fibonacci Quiz

1	What can you infer about the events that took place during Leonardo of Pisa's early life that lead to his desire to pursue mathematics? a. His ability to identify patterns in nature lead to his eventual discovery of the famed Fibonacci Sequence b. His ability to solve a problem quickly allowed him to identify patterns in nature. c. The lack of support from his father and Maestro drove him to daydream. d. He grew up in a city where the mathematicians' incorrect calculations resulted in the slant found in the leaning bell tower, which allowed him to travel around the world.
2	What conclusions can you draw about Leonardo's love of numbers and his fascination with the Arabic numeric system? a. He thought that the Arabic system was faster and should only be used to solve complicated math problems. b. He could find patterns on flowers that were representations of math in nature utilizing the Arabic numerals. c. He found that the Arabic system was a more efficient system that should be adapted by Western Civilization. d. Leonardo loved learning about calculations from different cultures around the world.
3	What conclusions can you make on the influence of the Arabic numeral system on Leonardo of Pisa's discovery of his numeric sequence? a. The Arabic numeric system was widely used by the merchants of the time and allowed them to keep better records. b. The use of the Arabic numeric system made the identification of numeric patterns in nature more easily recognizable. c. The Arabic system of counting featured only 1 symbol for each number. d. Leonardo's sequence features patterns that are easily recognizable in nature.
4	Thinking and working are concepts that are intertwined, why would the Maestro associate thinking with being a lazy daydreamer? a. When you are daydreaming you are not listening to people who are trying to have conversations with you, which could cause you to get in trouble. b. People who daydream are often more creative and are able to identify patterns in their environment, and this could make people envious or resentful of one another. c. When Leonardo was daydreaming he was solving more complex problems than what the Maestro could think of. d. Often when you are daydreaming you are not completing other activities so you may appear to be lazy.
5	What examples can you find in the passage to support the view that Europeans adopt the Arabic Numeric system? a. Utilizing 1 symbol to represent numbers was more efficient. b. Using abacuses was a time-consuming activity. c. Utilizing Roman Numerals often resulted in miscalculations. d. The Arabic Numeric system allowed merchants to quickly buy and sell goods.

6	How did the villagers' opinion of Leonardo change over time and why was this influential for the adaption of the Arabic numeric system throughout the western world? a. The Villagers recognized Leonardo's mathematical talents and reluctantly adapted his new numeric system. b. The villagers recognized that Leonardo was a talented mathematician, however, they were still adamantly against the adaptation of a new numeric system. c. The villagers felt that the Romans were more influential at the time and that Leonardo's ideas were those of a daydreamer. d. The villagers knew how smart Leonardo was, but felt that his ideas would result in Western Cultures being seen as inferior to other cultures.
7	Why do you think Leonardo chose to include the rabbit problem in his book and how would you rate its effectiveness in representing his sequence? a. Leonardo chooses to include the Rabbit problem to show people how rabbits reproduce in nature, by explaining this to the villagers they would be more likely to adopt the Arabic Numeric System. b. The use of the rabbit problem was not an effective representation of Leonardo's sequence because it is not how rabbits actually reproduce in nature. c. Leonardo chooses to include the rabbit problem in an attempt to explain how his sequence was found in nature in a manner that average people could understand. d. Leonardo chooses to include the rabbit problem in an attempt to show western cultures that his sequence could be more efficiently used with the Arabic Numeric System.
8	How is the number of petals found on a flower related to Leonardo's sequence? a. The number of petals demonstrates that Leonardo's sequence can be found on certain plants located on Italy's coast. b. The number of petals demonstrates that the reproduction patterns of plants is cohesive with the numbers found in Leonardo's sequence. c. The number of petals is crucial in understanding how Leonardo's sequence is found in nature. d. The number of petals represents Leonardo's sequence found in nature.
9	How could you test Leonardo's theory of numbers found in nature with a pinecone? a. Divide the number of scales by the diameter of the largest part of the pinecone then look for a spiral. b. Identify spirals that expand from the center of the pinecone and measure the various parts as the spiral grows. c. Count the number of scales on each level and add them together. d. Find the area of the pinecone and divide it by the number of scales found in a spiral.
10	Why do you think the spiral is consistently found throughout nature? a. Spirals allow plants to grow and utilize the most sunlight. b. Spirals can protect animals from predators through camouflage. c. Spirals allow animals and plants to grow and flourish in the most opportune way. d. The patterns found in spirals create a sense of balance in nature.

TBL Lesson Activity: Boy Bees- How Fibonacci's sequence is found through the reproductive patterns of bees. Each group will complete the Boy Bee worksheet and we will discuss their findings as a class. (students will be evaluated on their ability to follow the pattern 7 generations back)

Group Names _____

Boy Bees

Find the family tree for male bees using these simple rules:

- Male bees have only one parent - a female (They develop from unfertilized eggs.)
- Female bees have two parents – a male and a female.

Generations Back	M	F	Total
9			
8			
7			
6			
5			
4			
3	1	2	3
2	M F F F		2
1	0	1	1

Male Bee

Family tree begins here
(Work from the bottom up.)

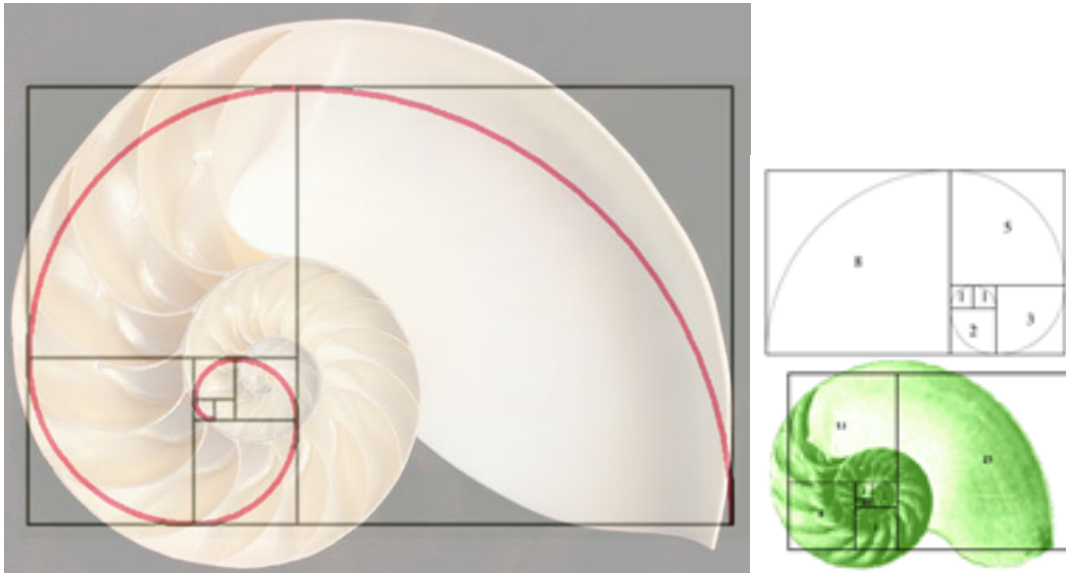


Complete the chart by indicating the number of ancestors the male bee has in each generation back. Remember, the generation preceding each male will only show a female parent for that male; the generation preceding each female will show both a female and male parent for that female.

What elements of patterns can you find in the reproduction of bees?

Bruner Assessment: Creating a Fibonacci Spiral

The teacher will model how to draw a proportionate Fibonacci spiral on graph paper. The students will then be asked to create their own spiral and then transform it into an item found in nature that features the spiral. Students will be assessed on their ability to create the proportionate spiral as well as their creativity in transforming it into a work of art.



Questioning Activity:

The students will then be split into 4 groups and assigned a video clip, article or image that features the Fibonacci sequence. Students will be asked to develop 5 questions that would fall in the upper 2 tiers of the house relating to the use of the sequence within the clip, article or image. After students have developed their questions, the students will come together and be broken into new groups with 1 representative from each of the 4 previous groups. Students will be asked to briefly summarize their clip, article, or image and explain how the sequence was represented, and then pose 1 of the questions to the group they felt was a higher order question to the group.

Group 1: Mr Magorium's Wonder Emporium

<https://www.youtube.com/watch?v=UXyNacOWvOg>

Group 2: Birthday cake scene from the movie 21

Group 3: Foxtrot comic strip

Group 4: Adventure Time Image

Students will be assessed on their ability to create a minimum of two 2nd or 3rd tier questions.

Summative Assessment: Performance Task

Urban murals transform a city's landscape creating a visual aesthetic that provides accessibility to art within communities. These murals express the artist's creativity and can

provide a window to your imagination that incorporates elements of nature in an urban environment. The Durham City Council has voted and would like to unveil two new murals during the 2020 Bimbe Cultural Arts Festival. The theme of the murals will be nature generates patterns. As an up-and-coming artist, you have been hired to design a mural with your team that features elements of symmetry found in nature utilizing Fibonacci's famous spiral as its inspiration. Working as a team each member must create their own individual spiral and transform into an image that represents how spirals are found throughout nature. These images will then be combined into one cohesive mural. Your team's mural will be submitted to the Durham City Council on the last day to showcase spirals in nature.

Section 5: Lesson Plans

TEACHER NAME		Lesson #
Chelsea Williams		1
MODEL	CONTENT AREA	MODEL
Team-Based Learning	Language Arts	Team-Based Learning
CONCEPTUAL LENS	LESSON TOPIC	
Patterns in nature	Life of Fibonacci	
LEARNING OBJECTIVES (from State/Local Curriculum)		
RI.3.1 Answer who and what, where, questions to demonstrate understanding of details in a text.		
RI.3.2 Identify the main topic and retell key details of a text.		
RI.3.5 Locate key facts or information in a familiar text.		
RI.3.8 Identify two related points an author makes in a familiar informational text		
THE ESSENTIAL UNDERSTANDING (What is the overarching idea students will understand as a result of this lesson?)	THE ESSENTIAL QUESTION (What question will be asked to lead students to “uncover” the Essential Understanding)	
Nature Generates Patterns	How does nature generate patterns?	
CONTENT KNOWLEDGE (What factual information will students learn in this lesson?)	PROCESS SKILLS (What will students be able to do as a result of this lesson?)	
Students will know that the origin of the Fibonacci numbers came from a sequence that is found in nature Student will know that the Fibonacci sequence is a repeating pattern Student will know that the Fibonacci sequence can be found in the reproductive patterns of bees Students will know that the Fibonacci sequence is found in nature Students will know the first 10 numbers that make up the Fibonacci sequence	Students will be able to analyze. Students will be able create generalizations. Students will be able to work collaboratively in a group. Students will be able to access, organize and synthesize information. Students will be able establish and defend a position. Students will be able to participate in high-level discussion and/or debate.	
GUIDING QUESTIONS		
What questions will be asked to support instruction? Include both “lesson plan level” questions as well as questions designed to guide students to the essential understanding		
Pre-Lesson Questions:	During Lesson Questions:	Post Lesson Questions:
What patterns can you identify within a pinecone? Where else can patterns be found in nature? Why are numbers essential in helping us patterns found in nature? What examples of patterns in nature can you identify on the first page of the read aloud? What is the relationship between working and thinking?	What can you infer about the events that took place during Leonardo of Pisa's early life that lead to his desire pursue mathematics? What conclusions can you draw about Leonardo's love of numbers and his fascination with the Arabic numeric system? What conclusions can you make on the influence of the Arabic numeral system on Leonardo of Pisa's discovery of his numeric sequence? Thinking and working are concepts that are intertwined, why would the Maestro associate thinking with being a lazy daydreamer? What examples can you find in the passage to support the view that Europeans adopt the Arabic numeric system? How did the villagers' opinion of Leonardo change over time and why was this influential for the adaption of the Arabic numeric system throughout the western world? Why do you think Leonardo chose to include the rabbit problem in his book and how would you rate its effectiveness in representing his sequence? How is the number of petals found on a flower related to Leonardo's sequence?	In what ways were western civilizations influenced by Fibonacci's ideas? Fibonacci's famed “rabbit problem” is not an accurate representation of how rabbits actually reproduce in the wild. How would you justify his choice of a fictional problem to represent symmetry in nature? Based on what you know, what would you have chosen to be an accurate representation of nature representing symmetry through the numbers 1,1,2,3,5,8,13 ect. If the reproduction of rabbits shows symmetry, what other elements of symmetry might a farmer experience on a daily basis? How does the reproduction pattern of bees reflect Fibonacci's pattern? What elements of patterns can you find in the reproduction of bees? How does nature generate patterns?

	How could you test Leonardo's theory of numbers found in nature with a pinecone? Why do you think the spiral is consistently found throughout nature?	
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DIFFERENTIATION

(Describe how the planned learning experience has been modified to meet the needs of gifted learners. Note: Modifications may be in one or more of the areas below. Only provide details for the area(s) that have been differentiated for this lesson.)

Content	Process	Product	Learning Environment
Students will be exposed above grade level content through Fibonacci's sequence in relation to nature	Students will facilitate a discussion at a higher level with limited teacher facilitation and make generalizations based on their discussion		

PLANNED LEARNING EXPERIENCES

(What will the teacher input? What will the students be asked to do? For clarity, please provide detailed instructions)

Engage and Connect - This phase focuses on piquing students' interest and helping them access prior knowledge. This is the introduction to the lesson that motivates or hooks the students.

When the students enter the room the teacher will show them a pinecone and ask them to identify any patterns they can within the pinecone. As students share their observations the teacher will list them on the board. The teacher will ask the students the pre-lesson questions:

Where else can patterns be found in nature?

Why are numbers essential in helping us patterns found in nature?

The teacher will then introduce the read aloud "Blockhead the Life of Fibonacci" and show students the first page. While students are observing the first page the teacher will ask:

What examples of patterns in nature can you identify on the first page of the read aloud?

After reading the 10th page of the read aloud the teacher will ask the students what is the relationship between working and thinking.

Explore - In this phase, the students have experiences with the concepts and ideas of the lesson. Students are encouraged to work together without direct instruction from the teacher. The teacher acts as a facilitator. Students observe, question, and investigate the concepts to develop fundamental awareness of the nature of the materials and ideas.

When students have finished listening to the read aloud they will be given a 10 question quiz via google forms bit.ly/blockhead112358. Students will be instructed to complete the quiz independently. When students have completed the assessment the teacher will group students in their Team-Based Learning teams. The teacher will direct the students to review their answers with their team members and come to a consensus on their responses to their quiz questions. Once a consensus is reached the teacher will have the team participate in a Quizizz. If a student response is incorrect, the team must revisit the question utilizing the text for evidence to support their opinion and come to a revised response. This will continue until the group has found the correct response.

Explain - Students communicate what they have learned so far and figure out what it means. This phase also provides an opportunity for teachers to directly introduce a concept, process, or skill to guide students toward a deeper understanding.

The teacher facilitates the discussion by going through each of the ten questions with the whole class. The teacher will identify and misconceptions the students may have had about Fibonacci's life through the discussion. While the discussion is happening the teacher will provide clarification and give factual and conceptual knowledge the students may need. If a student wishes to challenge an answer they may make a formal appeal by giving a written response that includes evidence cited from the passage. The teams will receive points based on the number of tries needed to identify the correct response. (Mini lessons may be given to individual students or small groups based on the teacher's observation and data collection of student misunderstandings)

Elaborate — Allow students to use their new knowledge and continue to explore its implications. At this stage students expand on the concepts they have learned, make connections to other related concepts, and apply their understandings to the world around them in new ways

Raising Rabbits Activity:

Fibonacci's patterns are found throughout the natural world. The rabbit problem in Fibonacci's book "Liber Abaci" presented a hypothetical problem with rabbits. While the rabbit problem was fictional (rabbits do not really breed in that way) bees do breed as described in the problem. The female bee is the queen bee, and the only one to develop from a fertilized egg. We will create a bee hive "family tree" to identify how Fibonacci's sequence is found in nature.

Evaluate: This phase assesses both learning and teaching and can use a wide variety of informal and formal assessment strategies.

Each group will complete the Boy Bee worksheet and we will discuss their findings as a class. (students will be evaluated on their ability to follow the pattern 7 generations back)

The Teacher will close the lesson by asking the post-lesson questions:

Looking at the rabbit problem what elements of symmetry are found within it calculations?

If the reproduction of rabbits shows symmetry, what other elements of symmetry might a farmer experience on a daily basis?

How does the reproduction pattern of bees reflect Fibonacci's pattern?

What elements of patterns can you find in the reproduction of bees?

How does nature generate patterns?

TEACHER NAME			Lesson #
Chelsea Williams			2
MODEL	CONTENT AREA	GRADE LEVEL	
VTS	Art	3	
CONCEPTUAL LENS		LESSON TOPIC	
Symmetry		Spirals in Nature	
LEARNING OBJECTIVES (from State/Local Curriculum)			
3.V.1.4 Understand characteristics of the Elements of Art, including lines, shapes, colors, textures, form, space, and value. 3.V.1.5 Understand characteristics of the Principles of Design, including repetition, movement, emphasis, contrast, balance, proportion, harmony, and unity. 3.CX.2.2 Understand how to use information learned in other disciplines, such as math, science, language arts, social studies, and other arts in visual arts.			
THE ESSENTIAL UNDERSTANDING (What is the overarching idea students will understand as a result of this lesson?)		THE ESSENTIAL QUESTION (What question will be asked to lead students to "uncover" the Essential Understanding?)	
Nature Generates Patterns		How does nature generate patterns?	
CONTENT KNOWLEDGE (What factual information will students learn in this lesson?)		PROCESS SKILLS (What will students be able to do as a result of this lesson?)	
Students will know that spirals are patterns Student will know that spirals are found in nature Students will know that there are many different kinds of patterns Student will know that the area of a spiral is a quantity that creates balance within its design		Students will be able to analyze. Students will be able to make meaning from visual representations. Students will be able to access, organize and synthesize information. Students will be able to evaluate. Students will be able to participate in high-level discussion and/or debate.	
GUIDING QUESTIONS What questions will be asked to support instruction? Include both "lesson plan level" questions as well as questions designed to guide students to the essential understanding			
Pre-Lesson Questions:	During Lesson Questions:	Post Lesson Questions:	
What is a pattern? What are some patterns that you notice as you look around the room? What is symmetry? How do patterns have some element of symmetry? Why would patterns be important in creating a sense of balance? Compare your pattern to that of a peer. In what ways can you identify a sense of balance in their artwork?	What do you see in this image? What do you see that makes you say that? What else do you see? What do you see that makes you say that? How are all of these images connected? What could you add to the previous observation? How do these images represent patterns? What do you see that represents patterns in nature? What patterns might a mathematician recognize in this image? What examples of addition, or multiplication can you identify in this image? How does quantity play a role in creating symmetry in a pattern?	How are the images in your picture connected? What makes you say that? What do you see in your image that represents patterns? What do you see in your image that represents nature and features an element of symmetry found in nature? What do you see that makes you say that? In what ways are your images connected through quantities? What do you see that makes you say that? How does your image represent a nature? What role does quantities play in the patterns found in your pictures? How does this quantity create a sense of symmetry? How does nature generate patterns?	
DIFFERENTIATION (Describe how the planned learning experience has been modified to meet the needs of gifted learners. Note: Modifications may be in one or more of the areas below. Only provide details for the area(s) that have been differentiated for this lesson.)			
Content	Process	Product	Learning Environment
Students will be exposed above grade level content through Fibonacci's sequence in relation to nature	Students will facilitate a discussion at a higher level with limited teacher facilitation and consider different perspectives through discussion and inferences		
PLANNED LEARNING EXPERIENCES (What will the teacher input? What will the students be asked to do? For clarity, please provide detailed instructions			

Engage and Connect - *This phase focuses on piquing students' interest and helping them access prior knowledge. This is the introduction to the lesson that motivates or hooks the students.*

Prior to the lesson, the teacher will create discussion norms with the group to establish an environment where students feel safe sharing their thoughts and options. The teacher will create a list of expectations along with the students and hang them in the front of the room.

The teacher will project the first image in from the book *Swirl by swirl - spirals in nature* illustrated by Beth Krommes, (2011). Students will be given a folded piece of card stock and markers and asked to create a pattern of their choosing that represents their personality. The teacher will ask students to consider the colors and shapes that represent them.

While students are displaying their work the teacher will ask the pre-lesson questions:

- What is a pattern?
- What are some patterns that you notice as you look around the room?
- What is symmetry?
- How do patterns have some element of symmetry?
- Why would patterns be important in creating a sense of balance?
- Compare your pattern to that of a peer. In what ways can you identify a sense of balance in their artwork?

Explore - *In this phase, the students have experiences with the concepts and ideas of the lesson. Students are encouraged to work together without direct instruction from the teacher. The teacher acts as a facilitator. Students observe, question, and investigate the concepts to develop fundamental awareness of the nature of the materials and ideas.*

The teacher will direct student's attention to the board and ask them to study the image for 3 minutes without discussing what they observe.

After the 3 minutes is up the teacher will ask:

- What do you see in this image?
- What do you see that makes you say that?
- (The first two questions are asked of individual students for multiple rounds. Allowing each student who volunteers to answer both questions. The teacher will paraphrase the student's response while pointing to the area in the picture to validate the response. It is crucial that the teacher gives no opinion or judgement about what the student says during this part.)
- When the students are no longer responding to the first two questions the teacher will ask:
- What else do you see in this picture?
- Followed by: What do you see that makes you say that?

Once several rounds have been completed the teacher will follow up with the question:

- How are all of these images connected?
- What could you add to the previous observation?
- How do these images represent patterns?

Explain - *Students communicate what they have learned so far and figure out what it means. This phase also provides an opportunity for teachers to directly introduce a concept, process, or skill to guide students toward a deeper understanding.*

The teacher will then refer back to the original image and ask the following questions:

- What do you see that represents patterns in nature?
- What patterns might a mathematician recognize in this image?
- What examples of addition, or multiplication can you identify in this image?
- How does quantity play a role in creating symmetry in a pattern?
- Students will then be broken into small groups for the next activity.

Elaborate —*Allow students to use their new knowledge and continue to explore its implications. At this stage students expand on the concepts they have learned, make connections to other related concepts, and apply their understandings to the world around them in new ways*

Students will be placed in 5 small groups and draw a number 2-6. The numbers will correspond to images 2-6 that the students will analyze while using VTS strategies.

They will ask each other :

- What do you see?
- What do you see that makes you say that?
- What else do you see?

After several rounds the teacher will ask the students to incorporate the following questions into their dialog:

- How are the images in your picture connected?
- What makes you say that?
- What do you see in your image that represents patterns?
- What makes you say that?
- What do you see in your image that represents nature and features an element of symmetry found in nature?
- What do you see that makes you say that?
- In what ways are your images connected by nature?

What do you see that makes you say that?

Evaluate: *This phase assesses both learning and teaching and can use a wide variety of informal and formal assessment strategies.*

Each group will then answer the following questions, based on their discussions:

How does your image represent a nature?

What role does quantities play in the patterns found in your pictures?

How does this quantity create a sense of symmetry?

How does nature generate patterns?

The groups will then be asked to share out their observations and answers to the prior questions with the class and asked to make a connection between their image and the first image that was projected on the screen.

Image 1



Krommes, B. (2011). *Swirl by swirl - spirals in nature*. Houghton Mifflin Harcourt Publ.



Krommes, B. (2011). *Swirl by swirl - spirals in nature*. Houghton Mifflin Harcourt Publ.



Krommes, B. (2011). *Swirl by swirl - spirals in nature*. Houghton Mifflin Harcourt Publ.



Krommes, B. (2011). *Swirl by swirl - spirals in nature*. Houghton Mifflin Harcourt Publ.



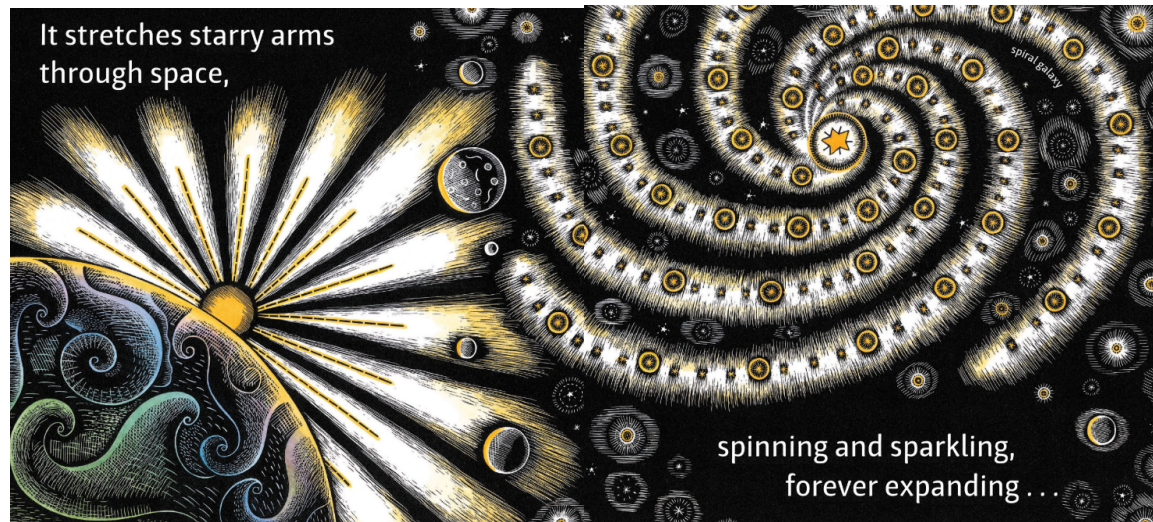
Krommes, B. (2011). *Swirl by swirl - spirals in nature*. Houghton Mifflin Harcourt Publ.



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TEACHER NAME			Lesson #
Chelsea Williams			3
MODEL	CONTENT AREA	Grade	
Bruner	Art	3 rd	
CONCEPTUAL LENS		LESSON TOPIC	
Patterns		What is an Artist	
LEARNING OBJECTIVES (from State/Local Curriculum)			
3.V.1. Use the language of visual arts to communicate effectively 3.V.2 Apply creative and critical thinking skills to artistic expression 3.V.3 Create art using a variety of tools, media, and processes, safely and appropriately			
THE ESSENTIAL UNDERSTANDING <i>(What is the overarching idea students will understand as a result of this lesson?)</i>		THE ESSENTIAL QUESTION <i>(What question will be asked to lead students to "uncover" the Essential Understanding)</i>	
Nature Generates Patterns		How does nature generate patterns?	
CONTENT KNOWLEDGE <i>(What factual information will students learn in this lesson?)</i>		PROCESS SKILLS <i>(What will students be able to do as a result of this lesson?)</i>	
Students will know that artists draw their inspiration from the world around them Student will know how artist transfer works of art to larger surfaces Student will know that the Fibonacci sequence is a repeating pattern Students will know that the Fibonacci sequence is found in nature		Students will be able to analyze. Students will be able create generalizations. Students will be able to work collaboratively in a group. Students will be able to access, organize and synthesize information. Students will be able to participate in high-level discussion and/or debate. Students will generate numbers in the Fibonacci sequence	
GUIDING QUESTIONS <i>What questions will be asked to support instruction?</i> <i>Include both "lesson plan level" questions as well as questions designed to guide students to the essential understanding</i>			
Pre-Lesson Questions:	During Lesson Questions:	Post Lesson Questions:	
What do artists do? Where might artists create? What are some of the tools artists use? What different mediums can artists use to express their work? (examples include murals, self-portraits, etc.) Where to artist draw their inspiration? How can artist use mathematical patterns found in nature to create works of art?	How might Kristen Farr have been influenced Fibonacci's sequences in creating her art? In what ways can you identify Fibonacci's sequence in Farr's art? In what ways can artist draw inspiration from the natural world around them? Where in nature might we find examples of spirals in nature? How could an artist represent these examples in a mural?	How does Fibonacci's sequence generate patterns in nature through numbers? How could Fibonacci's spiral be used to generate a work of art? How could an artist transfer a sketch to a larger surface to scale? How does nature generate patterns?	
DIFFERENTIATION <i>(Describe how the planned learning experience has been modified to meet the needs of gifted learners. Note: Modifications may be in one or more of the areas below. Only provide details for the area(s) that have been differentiated for this lesson.</i>			
Content	Process	Product	Learning Environment
Students will be exposed above grade level content through Fibonacci's sequence in relation to nature	Students will Facilitate a discussion at a higher level with limited teacher facilitation and make generalizations based on their discussion		
PLANNED LEARNING EXPERIENCES <i>(What will the teacher input? What will the students be asked to do? For clarity, please provide detailed instructions)</i>			
Engage and Connect - This phase focuses on piquing students' interest and helping them access prior knowledge. This is the introduction to the lesson that motivates or hooks the students. As the students enter the room the teacher will have various identifiable art supplies such as paint brushes and paint, along with some unique supplies students might not recognize as art supplies; rulers, protractors, grid paper, cardboard etc. The teacher will also have several props that contain spirals or geometric shapes such as pine cones, shells, and bee hives. Students will be given a blank sheet of paper and asked to create an independent list of what they know about artists. The list should include: What artist do What artist wear What tools they might use Where they might create their art How old they are			

What characteristics artist should possess
What formal training they should receive

After 5 minutes of listing, students will share their list with the class. While students are sharing, the teacher will create a visual on the board that includes all of their responses. The teacher will ask students to elaborate on their responses while sharing with the class (what makes you say that? Would anyone else like to add to the idea presented?). The teacher will ask the pre-lesson questions along with Where do artist draw inspiration from?

Explore - *In this phase, the students have experiences with the concepts and ideas of the lesson. Students are encouraged to work together without direct instruction from the teacher. The teacher acts as a facilitator. Students observe, question, and investigate the concepts to develop fundamental awareness of the nature of the materials and ideas.*

After reviewing the list, the teacher introduces 2 different videos on artists. The first video features an artist who creates art from geometric shapes. The second video features an artist who has students create self-murals and has created several murals in LA. Students will be instructed to watch the videos and focus on how artist act, what they do, where their draw their inspiration from, and what characteristics a creator should have.

<https://www.youtube.com/watch?v=OX1r-3-VK-0>

<http://newsroom.ucla.edu/stories/a-legacy-that-lives-on-the-walls>

After the video the students will refer back to their original list. The teacher will ask students what other things they would like to add to the list. The teacher will then ask the during lesson questions:

How might Kristen Farr have been influenced Fibonacci's sequences in creating her art?

In what ways can you identify Fibonacci's sequence in Farr's art?

In what ways can artist draw inspiration from the natural world around them?

Where in nature might we find examples of spirals in nature?

How could an artist represent these examples in a mural?

The teacher will explain to the students that artists can draw inspiration from the world around them and draw the classes attention to the pre-lesson props. The teacher will break the students into groups of 4-5 students and explain to them that they are now artist and will create works of art that represent spirals in nature. Each group will observe an item found in nature and identify the spiral located within the object. The teacher will create stations featuring seashells, pinecones, sunflowers, and images of an aloe plants and snail shells and allow students to explore the following websites featuring spirals in art/nature:

<https://paterakoristudios.com/spirals-in-art/>

<https://www.robertharding.com/blog/2014/01/27/spirals-in-nature/>

<https://www.pinterest.com/wmrod/spirals-in-art-and-nature/>

<https://www.youtube.com/watch?v=kkGeOWYOFoA&t=12s>

<https://www.markmitchellpaintings.com/blog/the-fibonacci-sequence-in-artistic-composition/>

<https://www.youtube.com/watch?v=-JSn6W1YZio>

<https://www.youtube.com/watch?v=SjSHVDfXHQ4>

The students will be provided with a sketch pad, a black marker and colored pencils (tools an artist would use when drawing inspiration). The students will rotate from group to group silently identifying the pattern located within the object. When they are finished observing they will create a rendition of the newly found spiral in their note pad. After each of the observation stations, the students will meet with their groups and discuss that spirals they found within their research.

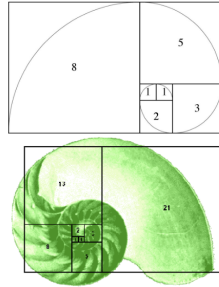
Explain - *Students communicate what they have learned so far and figure out what it means. This phase also provides an opportunity for teachers to directly introduce a concept, process, or skill to guide students toward a deeper understanding.*

After students have completed all stations, the teacher will provide time for the groups to have one final meeting to address that question where in nature we might find examples of spirals and how could an artist represent these examples in a mural? The students will then report their findings and draw conclusions that will be shared during a group discussion.

Elaborate —*Allow students to use their new knowledge and continue to explore its implications. At this stage students expand on the concepts they have learned, make connections to other related concepts, and apply their understandings to the world around them in new ways*

The students will be given a piece of grid paper and a compass. The teacher will model how to use grid paper and compass to create a spiral using Fibonacci's sequence. The teacher will explain that when murals are created the artists must first create a sketch that can be transferred to the

mural to scale through a grid. The students will then create their own spiral on the graph paper by adding the area of the squares together following the sequence. Once students have created their spiral they will use the outline to create an animal or plant that features the spiral in nature which will be used to create their mural.



*Depending on time students will begin to grid the large pieces of cardboard to prepare them for the mural

Evaluate: *This phase assesses both learning and teaching and can use a wide variety of informal and formal assessment strategies.*

The Teacher will close the lesson by asking the post-lesson questions:

How does Fibonacci's sequence generate patterns in nature through numbers?

How can Fibonacci's spiral be used to generate a work of art?

How could an artist transfer a sketch to a larger surface to scale?

How does nature generate patterns?

TEACHER NAME		Lesson #
Chelsea Williams		4
MODEL	CONTENT AREA	Grade
Questioning	Language Arts	3 rd
CONCEPTUAL LENS	LESSON TOPIC	
Questioning	Patterns featuring the Fibonacci Sequence	
LEARNING OBJECTIVES (from State/Local Curriculum)		
SL.3.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others’ ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion. b. Follow agreed-upon rules for discussions. c. Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others. d. Explain their own ideas and understanding in light of the discussion.		
SL.3.3 Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.		
THE ESSENTIAL UNDERSTANDING (What is the overarching idea students will understand as a result of this lesson?)	THE ESSENTIAL QUESTION (What question will be asked to lead students to “uncover” the Essential Understanding)	
Nature Generates Patterns	How does nature generate patterns?	
CONTENT KNOWLEDGE (What factual information will students learn in this lesson?)	PROCESS SKILLS (What will students be able to do as a result of this lesson?)	
Students will know that patterns are can be made up of sequences of numbers Student will know that patterns are found in nature Students will know that different disciplines utilize patterns Student will know that patterns can be used to generate codes Students will know that the Fibonacci Numeric Sequence if found throughout popular culture	Students will be able to analyze. Students will be able to make meaning from visual representations. Students will be able to access, organize and synthesize information. Students will be able to evaluate. Students will be able to participate in high-level discussion and/or debate. Students will be able to create questions that require higher order thinking	
GUIDING QUESTIONS What questions will be asked to support instruction? Include both “lesson plan level” questions as well as questions designed to guide students to the essential understanding		
Pre-Lesson Questions:	During Lesson Questions:	Post Lesson Questions:

What do you know about patterns? How can sequences of patterns be represented in nature? How are patterns represented in Fibonacci's sequence? What other disciplines might use sequences of patterns? How could identifying patterns help detectives solve crimes? Where might detectives look for patterns when attempting to solve crimes?	What is your opinion of Fatty's decision to hide the key in the wall? How could the Fibonacci sequence be represented in a different way utilizing the patterns on the wall? Where did Fatty hide the key? (This is an example of a lower level question to help students easily identify the difference) In what ways could Fatty have hidden the key without using an extra tile? If you were Fatty where else, could you have hidden a key in your house that would require the Fibonacci Sequence to find? Give an example of how Fatty could have use patterns in nature to hide the key outside his house? Padlocks often require a sequence of numbers to unlock. What sequence would you create that utilizes a form of Fibonacci's sequence? Explain how number patterns can be represented in nature? What would have happened if the tile wall were greater than 5 tiles high?	What changes will you make to improve the types of questions you ask? In what ways are patterns in nature utilized to generate codes? How might you incorporate Fibonacci's sequence in your design for the mural? How could you use patterns in nature to generate secret codes? How does nature generate patterns?
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DIFFERENTIATION

(Describe how the planned learning experience has been modified to meet the needs of gifted learners. Note: Modifications may be in one or more of the areas below. Only provide details for the area(s) that have been differentiated for this lesson.)

Content	Process	Product	Learning Environment
Students will be exposed above grade level content through Fibonacci's sequence in relation to nature	Students will facilitate a discussion at a higher level with limited teacher facilitation and consider different perspectives through discussion and inferences		

PLANNED LEARNING EXPERIENCES

(What will the teacher input? What will the students be asked to do? For clarity, please provide detailed instructions)

Engage and Connect - This phase focuses on piquing students' interest and helping them access prior knowledge. This is the introduction to the lesson that motivates or hooks the students.

The teacher will ask the following questions:

What do you know about patterns?

How can sequences of patterns be represented in nature?

How are patterns represented in Fibonacci's sequence?

The teacher will then ask students have they ever invented a secret code with a friend and how they were able to remember the corresponding letters, numbers, or symbols. What codes are around us every day that we might not even think about? (Computer codes, Cell phone codes, etc?) Where do creators draw inspiration for these codes?

The teacher will read the story "Wild Fibonacci: Nature's Secret Code Revealed" and have students list how Fibonacci's code (1,1,2,3,5,8 etc.) is hidden throughout nature. When the read about is over the teacher will have the students share out their list and ask how they might use Fibonacci's sequence to develop their own code.

Explore - In this phase, the students have experiences with the concepts and ideas of the lesson. Students are encouraged to work together without direct instruction from the teacher. The teacher acts as a facilitator. Students observe, question, and investigate the concepts to develop fundamental awareness of the nature of the materials and ideas.

Prior to showing the video featuring Fibonacci's sequence the teacher will ask:

What other disciplines might use sequences of patterns?

How could identifying patterns help detectives solve crimes?

Where might detectives look for patterns when attempting to solve crimes?

Students will then watch Mathnet - Case of the Willing Parrot (Recap & Finale) Pt.2.

<https://www.youtube.com/watch?v=vLhQfcZ-BWk>

Explain - Students communicate what they have learned so far and figure out what it means. This phase also provides an opportunity for teachers to directly introduce a concept, process, or skill to guide students toward a deeper understanding.

After students have had an opportunity to watch the video the teacher will ask the following during lesson questions:

1. What is your opinion of Fatty's decision to hide the key in the wall?
2. How could the Fibonacci sequence be represented in a different way utilizing the patterns on the wall?
3. Where did Fatty hide the key? (This is an example of a lower level question to help students easily identify the difference)
4. In what ways could Fatty have hidden the key without using an extra tile?
5. If you were Fatty where else, could you have hidden a key in your house that would require the Fibonacci Sequence to find?
6. Give an example of how Fatty could have use patterns in nature to hide the key outside his house?
7. Padlocks often require a sequence of numbers to unlock. What sequence would you create that utilizes a form of Fibonacci's sequence?
8. Explain how are number patterns represented in nature?
9. What would have happened if the tile wall was greater than 5 tiles high?

The teacher will review the 3 types of question (Factual, conceptual, and provocative). The teacher will then show an image of Costa's house and explain the different levels. The students will then look at questions 3, 5, 7, and 9 and discuss where in the house the questions might fall and why.

Elaborate —Allow students to use their new knowledge and continue to explore its implications. At this stage students expand on the concepts they have learned, make connections to other related concepts, and apply their understandings to the world around them in new ways

The students will then be split into 4 groups and assigned a video clip, article or image that features the Fibonacci sequence. Students will be asked to develop 5 questions that would fall in the upper 2 tiers of the house relating to the use of the sequence within the clip, article or image. After students have developed their questions, the students will come together and be broken into new groups with 1 representative from each of the 4 previous groups. Students will be asked to briefly summarize their clip, article, or image and explain how the sequence was represented, and then pose 1 of the questions to the group they felt was a higher order question to the group.

Group 1: Mr Magorium's Wonder Emporium <https://www.youtube.com/watch?v=UXyNacOWvOg>

Group 2: Birthday cake scene from the movie 21

Group 3: Foxtrot comic strip

Group 4: Adventure Time Image

Evaluate: This phase assesses both learning and teaching and can use a wide variety of informal and formal assessment strategies.

The students will then discuss which clip, article or image best demonstrated the concept that nature generates

patterns. The teacher will then pose the post lesson questions:

What changes will you make to improve the types of questions you ask?

In what ways are patterns in nature utilized to generate codes?

How might you incorporate Fibonacci's sequence in your design for the mural?

How could you use patterns in nature to generate secret codes?

How does nature generate patterns?

To close out the lesson the students will be asked to develop their own code utilizing the Fibonacci sequence.

The Three Story Intellect



There are **one-story intellects**, two story intellects, and three-story intellects with skylights.

All fact collectors, who have no aim beyond their facts, are one-story men.

Two-story men compare, reason, generalize, using the labors of the fact collectors as well as their own.

Three-story men idealize, imagine, predict--their best illumination comes from above, through the skylight.

Oliver Wendell Holmes



Costa's 3 Levels of Inquiry

Level 1: The **answer can be found in the text** (either directly or indirectly). This type of question is very concrete and pertains only to the text. Level 1 questions **ask for facts about what has been heard or read**. Information is recalled in the exact manner/form it was heard or read. These types of questions help determine if you have read the material and understand what you have read.

Level 2: The **answer can be inferred from the text**. This type of question, although more **abstract** than a Level 1 questions, deals only with the text. Information can be broken down in parts. Involves examination, analysis, causes of details.

Level 3: **Answer goes beyond text**. This type of question is **abstract**, and may not pertain to text. These questions ask that **judgments be made from information**. They also give **opinions** about issues, **judge the validity** of the ideas or other products and **justify opinions** and ideas.



Group 2 Prompt:

Ben is a student in an advanced math class at MIT, for his birthday his friends give him the following cake:



Group 3 Prompt:



Group 4 Prompt:

Fin is looking for a secret Enchiridion book for Princess Bubble Gum. When he finds it the numbers 8,13, 21 are written on the back cover.



Section 6: Resources

Books-

Blockhead: The life og Fibonacci

DAgnese, J., & OBrien, J. (2010). *Blockhead: The life of Fibonacci*. New York: Henry Holt.

Wild Fibonacci Natures Secret Code Revealed

Hulme, J. N., & Schwartz, C. (2010). *Wild Fibonacci: Natures secret code revealed*. Berkeley: Tricycle Press.

Swirl by Swirl- Spirals in nature

Krommes, B. (2011). *Swirl by swirl - spirals in nature*. Houghton Mifflin Harcourt Publ.

Student website resources-

bit.ly/blockhead112358 Google Forum featuring the TBL 10-question quiz

bit.ly/112358question Google Site featuring student images for Questioning Lesson

<http://bit.ly/spiralsinnature> Student reference page featuring the Performance Task, VTS Lesson images from the book Swirl by Swirl and the following websites featuring spirals in nature

- <https://paterakoristudios.com/spirals-in-art/> -various works of art featuring spirals throughout history
- <https://www.robertharding.com/blog/2014/01/27/spirals-in-nature/> - images of spirals found in or on plants
- <https://www.youtube.com/watch?v=kkGeOWYOFoA&t=12s> - a 4 minute YouTube video reviewing the Fibonacci sequence and shows how it is found in various plants and shells.
- <https://www.markmitchellpaintings.com/blog/the-fibonacci-sequence-in-artistic-composition/> Demonstrates how the golden ratio is found throughout various works of art
- <https://www.youtube.com/watch?v=-JSn6W1YZio> - A YouTube video explaining an artist theory on why spirals are found throughout nature
- <https://www.youtube.com/watch?v=SjSHVDfXHQ4> - A Ted Talk featuring how our daily lives are impacted by the Fibonacci sequence

Teacher Resources

Garland, T. H. (1997). *Fibonnaci fun: Fascinating activities with intriguing numbers*. Palo Alto, CA: D. Seymour Publications.

<https://www.youtube.com/watch?v=OX1r-3-VK-0> -features Kristin Farr an artist who creates art from geometric shapes

<http://newsroom.ucla.edu/stories/a-legacy-that-lives-on-the-walls> -features Judy Baca an artist who has students create self-murals and has created several murals in LA.

<https://www.youtube.com/watch?v=vLhQfcZ-BWk> Mathnet: the case of the willing parrot