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Fibonacci

VITAL INFORMATION

Subject(s):

Algebra, Geometry, English, and Art

Unit and Topic:

Number Patterns, Measurement, and Limits

Grade/Level:

11-12

Time Allotment:

6 class periods. 50 Min. per class.

Pre-Requisite Skills:

Ratios, proportions, basic geometric constructions

Objective:

***Knowledge:**

Define vocabulary

***Comprehension:**

Order, interpret, and predict patterns

***Application:**

Solve problems by calculating ratios and proportions

Modify and illustrate knowledge of content

Discover the concept of a limit

***Analysis:**

Seeing patterns and making inferences about them

Making connections

***Synthesis:**

Design, create, and produce books based on phi

Summary:

PREPARATION

Instructional Materials:

graph paper, construction paper, calculators, scissors, rulers, glue,
Internet access, text, activity sheets, calculator instructions

computer, Dana

Resources:

- The number of computers required is 1 per student.
- Materials and resources:
 - <http://www.moonstar.com/~nedmay/chromat/fibonaci.htm>
 - <http://www.mcs.surrey.ac.uk/Personal/R.Knott/Fibonacci/fibpuzzles.html#beeline>
 - <http://goldennumber.net/>
 - http://www.geocities.com/cyd_conner/nature.html?200511
(pictures)

Student Assistance Team Manual
West Virginia Department of Education
Division of Instructional and Student Services

Adapting Curriculum and Instruction in Inclusive Classroom: A
Teacher's Desk Reference
The Center for School and Community Integration
Institute for the Study of Develomental Disabilities
2853 East Tenth Street
Bloomington, Indiana 47408-2601
Telephone: (812) 855-6508

LDLOnLine
Classroom Accommodation List
Appropriate School-Based Accommadations and Interventions

Larson, Boswell, & Stiff, "Geometry Concepts and Skills",
McDougal Littell, Evanston, IL, 2005

Serra, Michael, "Discovering Geometry", Key Curriculum Press, Emeryville, CA, 2003

Attachments:

1. [Calculator Instructions](#)

IMPLEMENTATION

Introduction/Motivation:

Day 1: Work in groups of 5. Students will 'introduce' themselves so that each person shakes hands with each other person. How many ways can 2 people shake hands? 3 people? 4 people? 5 people? (Make a chart.) Do you see a pattern? Can you predict the outcome for 10 people?

Learning Context:

This lesson is part of a unit on number patterns.

Procedure:

Day 1:

*Motivational activity

*Vocabulary:

inductive reasoning - a process that includes looking for patterns and making conjectures

conjecture - an unproven statement that is based on patterns and observations

counterexample - an example that shows a conjecture is false

*Discuss the vocabulary words and how they are used to recognize patterns. Discuss how to prove a conjecture false - one contradictory piece of data.

*Show examples of number, letter, and picture patterns.

*Assign pp 5-7 8-26 even, 27,33; pp 11-13 5-7, 13-19
(text: Larson, Boswell, & Stiff)

*Assign: "Challenge" patterns (text: Serra, p 99)

Day 2:

*Warm up: What are the next three numbers in this sequence:

0,1,1,2,3,5,8,...?

*Vocabulary:

ratio - a comparison of 2 quantities, often written in fraction form

limit - the utmost extent; a prescribed maximum or minimum amount, quantity, or number

proportion - an equation that states two ratios are equal

ellipsis - (...) three dots which indicate that the pattern continues indefinitely

phi - take any line segment, divide it into two parts so that the ratio of the whole segment to the larger of the two parts is equal to the ratio of the larger of the two parts to the smaller of the two parts (that ratio is $\phi = \frac{(\sqrt{5} + 1)}{2} = 1.618033988749895\dots$)

*Discuss the vocabulary words and the Fibonacci sequence.

*Do calculator activity on Fibonacci, ratios, and limits. (Hopefully, the students will 'discover' phi.) If they have trouble 'discovering' phi or understanding the idea of a limit it could be helpful to graph the numbers in L3 and draw a line for phi. (see attachment)

*Assign: on the Internet: Find one example of the Fibonacci sequence of phi in each of the following:

art, music, nature, mathematics, architecture, and (if possible) literature

*Look at Fibonacci spirals.

Day 3:

Fun With Fibonacci!

*'Making a Bee Line' activity. (see handout)

*Discussion of Fibonacci and phi in art, music, nature, mathematics, architecture, and literature.

*Demonstration of the Fibonacci spiral. (see attachment)

*Question: How can I divide a line segment into two parts so that the ratio of the longer part to the shorter part and the ratio of the whole segment to the longer part equals phi?

*Easy answer: Use the Fibonacci sequence/numbers - but remember the ratios we find here are an approximation (not quite accurate), especially with the lower numbers.

*Algebraic answer: Set up a ratio - If the whole segment is 10 units, then 10 divided by what number gives you phi?

*Have students try several numbers. Does this process work for every positive number? Does the ratio hold up for the whole segment/longer part and the longer part/ shorter part?

*Fibonacci puzzle: Does $64 = 65$? (see handout)

Day 4-6:

*Students will work in groups of two to design, illustrate, write, and publish a children's book based on the Fibonacci numbers and/or phi. The book should be at least five pages long and include a cover and a title page. They must use the Fibonacci numbers or phi at least twice in either the book's dimensions or the illustrations. Students are encouraged to include these concepts in the story itself. Students will have access to Danas or Microsoft Word to write their story, but this is not a requirement.

Final day:

*Students will write a journal entry to reflect on this project. This entry should include:

- a recap of the math concepts they used in the project
- their feelings about both the project and the process
- their feelings about the book they produced
- whether or not they would repeat the project and why

Attachments:

1. [Calculator Instructions for Fibonacci and Phi.doc](#)
2. [Creative Book Based on Phi.doc](#)

Links:

1. [Fibonacci Spirals](#)

2. Making a Bee Line

Differentiated Instruction:

Multiple Intelligences used in this lesson:

- * Visual/Linguistic - Writing a children's story about phi
- * Visual/Spatial - Illustrating the story with art showing phi
- * Logical/Mathematical - General math concepts; TI 83 or 84 used to get phi dimensions of book pages, cover, and/or art illustrations
- * Musical/Rhythmical - Internet exploration for Fibonacci sequence and phi in music
- * Interpersonal/Social - Grouping students with peers to write their creative book based on phi; various math activities
- * Intrapersonal/Individual - Each student will do their part of the book; various math assignments
- * Bodily/Kinesthetic - Hands-on reading of their books to younger children and classmates
- * Naturalistic - Fibonacci and phi in nature; pictures from nature included in their books

Sample Student Products:

See attachments of students' books and reflections

Attachments:

1. [Mvc-026f.jpg](#)
2. [Mvc-027f.jpg](#)
3. [Mvc-028f.jpg](#)
4. [Mvc-029f.jpg](#)
5. [Mvc-030f.jpg](#)
6. [Mvc-031f.jpg](#)

7. [Mvc-032f.jpg](#)
8. [Mvc-033f.jpg](#)
9. [Mvc-034f.jpg](#)
10. [Mvc-035f.jpg](#)
11. [Mvc-036f.jpg](#)
12. [Mvc-037f.jpg](#)
13. [Mvc-038f.jpg](#)
14. [JOURNAL REFLECTION OF PHI BOOK.doc](#)

Collaboration:

Students will work collaboratively & individually. Students will work in groups of 2.

Author's Comments & Reflections:

Before discussing phi - you may want to remind them of pi. The ratio of the circumference of any circle to its diameter is $\pi = 3.14\dots$ They will probably already be familiar with this relationship so phi will not seem so foreign to them.

For the 'Making a Bee Line' activity, suggest that students make a chart.

STANDARDS & ASSESSMENT

Standards:

 **WV- West Virginia Content Standards and Objectives**

- **Subject** : Art
 - **Grade or Course** : General Art II
 - **Standard** : Standard 6: Multi-disciplinary Connections (VA.S.6)
Students will:
 - Detail** : identify characteristics of the visual arts and other disciplines; and
 - Detail** : analyze by comparing and contrasting connections between disciplines.
 - Objective VAII.6.1**: select and compare artwork using specific historical issues or themes to other subject areas.
 - Objective VAII.6.2**: apply creative problem solving techniques to a multi-disciplinary artwork.
- **Subject** : Math
 - **Grade or Course** : Algebra I
 - **Standard** : Standard 2: Algebra (MA.S.2)
Students will:
 - Detail** : demonstrate understanding of patterns, relations, and functions;
 - Detail** : use mathematical models to represent and understand quantitative relationships; and
 - Objective A1.2.5** : analyze a given set of data for the existence of a pattern numerically, algebraically and graphically; determine the domain and range; and determine if the relation is a function.
 - **Grade or Course** : Geometry and Applied Geometry
 - **Standard** : Standard 3: Geometry (MA.S.3)
Students will:
 - Detail** : solve problems using visualization, spatial reasoning, and

geometric modeling through communication, representation, reasoning and proof, problem solving, and making connections within and beyond the field of mathematics.

Objective G.3.2 : differentiate between inductive and deductive reasoning.

• **Subject** : Reading and Language Arts

• **Grade or Course** : Eleventh Grade

• **Standard** : Standard 2: Writing (RLA.S.2)

Students will employ a wide range of writing strategies to communicate effectively for different purposes by:

Detail : developing the writing process;

Detail : applying grammatical and mechanical properties in writing; and

Detail : gathering and using information for research purposes.

Objective RLA.11.2.2 : generate topics and plan approaches to writing (e.g., graphic organizers; outlines) using pre-writing strategies.

Objective RLA.11.2.1 : employ writing strategies to address specific purposes and audiences (e.g., narrative; expository; descriptive and/or persuasive).

Objective RLA.11.2.3 : employ drafting strategies for interdisciplinary writing tasks.

Objective RLA.11.2.5 : develop a composition that is focused and coherent and has a clear, logical progression of ideas.

Objective RLA.11.2.15 : apply the concept of intellectual property and plagiarism in all media (e.g., media copyright laws; private/public domain).

USA- ISTE: Profiles for Technology Literate Students (includes NETS for Students)

- **Grade** : Grades 9-12

Numbers in parentheses following each performance indicator refer to the standards category to which the performance is linked. The categories are:

1. Basic operations and concepts
2. Social, ethical, and human issues
3. Technology productivity tools
4. Technology communications tools
5. Technology research tools
6. Technology problem-solving and decision-making tools

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- Performance Objective 5:** Use technology tools and resources for managing and communicating personal/professional information (e.g., finances, schedules, addresses, purchases, correspondence). (3, 4)
- Performance Objective 7:** Routinely and efficiently use online information resources to meet needs for collaboration, research, publications, communications, and productivity. (4, 5, 6)
- Performance Objective 10:** Collaborate with peers, experts, and others to contribute to a content-related knowledge base by using technology to compile, synthesize, produce, and disseminate

information, models, and other creative works. (4, 5, 6)

Assessment/Rubrics:

Rubrics:

Fibonacci/Phi book