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Instructional Recipe

Where Do You See Math in Nature?

Geometry
High School

Step 1 – Ask

Objectives: Students will identify geometric patterns that include the Fibonacci sequence in nature. Students will identify objects in nature that follow the Golden Ratio. Students will be able to explain why the Golden Ratio results in better dispersal of seeds or leaves than other ratios.

Introduction: Bring a sample of flowers to class. Distribute 4 or 5 flowers to groups of students. Have students count the number of petals on each flower. Ask students if they observe any patterns in the way the petals are arranged on a flower. Are there any patterns in the number of petals on a flower?



"Bee Pollinating Flower." Online Photograph. EBSCO Image Collection. 13 Oct. 2008 < <http://search.ebscohost.com/login.aspx?direct=true&db=imh&AN=imh213885&site=src-live>>.

Ask:

- ★ Who was Leonardo Pisano (Fibonacci)?
- ★ What is the Fibonacci sequence?
- ★ Where do the Fibonacci numbers appear in nature?
- ★ What is the Golden Ratio or Golden Number (Phi)?
- ★ Where does the Golden Ratio appear in nature?

Vocabulary:

- ★ Fibonacci sequence
- ★ Golden Ratio
- ★ Phi

Geometry TEKS:

(c) Geometric patterns.

- (1) The student uses numeric and geometric patterns to make generalizations about geometric properties, including properties of polygons, ratios in similar figures and solids, and angle relationships in polygons and circles.
- (2) The student uses properties of transformations and their compositions to make connections between mathematics and the real world in applications such as tessellations or fractals.

Technology Application TEKS:

- (2) Foundations. (A) demonstrate proficiency in the use of a variety of input devices such as mouse/track pad, keyboard, microphone, digital camera, printer, scanner, disk/disc, modem, CD-ROM, or joystick
- (4) Information acquisition. (A) use strategies to locate and acquire desired information on LANs and WANs, including the Internet, intranet, and collaborative software; and (B) apply appropriate electronic search strategies in the acquisition of information including keyword and Boolean search strategies;
- (6) Information acquisition. (A) determine and employ methods to evaluate the electronic information for accuracy and validity; (B) resolve information conflicts and validate information through accessing, researching, and comparing data; and (C) demonstrate the ability to identify the source, location, media type, relevancy, and content validity of available information;
- (7) Solving problems. (D) demonstrate proficiency in the use of multimedia authoring programs by creating linear or non-linear projects incorporating text, audio, video, and graphics; (H) use interactive virtual environments, appropriate to level, such as virtual reality or simulations;
- (11) Communication. (A) publish information in a variety of ways including, but not limited to, printed copy, monitor display, Internet documents, and video. (B) design and create interdisciplinary multimedia presentations for defined audiences including audio, video, text, and graphics.

Step 2 – Investigate

Search the Student Research Center for “Fibonacci Sequence” or “Golden Ratio”
K-12 Database Resources:

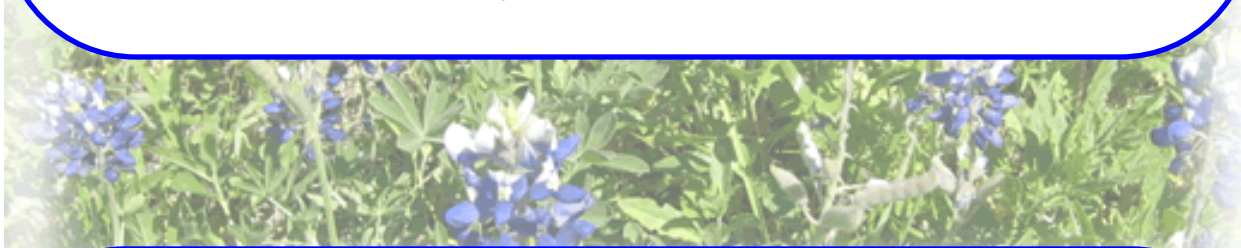
- ★ [Golden Blossoms, Pi Flowers](#). By: Peterson, Ivars. *Math Trek*, Aug2002, pN.PAG, 00p; Reading Level (Lexile): 850; (AN 7397581)
- ★ [Fibonacci's Missing Flowers](#). By: Peterson, Ivars. *Math Trek*, Jun2006, p2-2, 1p, 1 chart; Reading Level (Lexile): 960; (AN 21678087)
- ★ [The first mathematical model](#). By: Scheid, Francis. *Odyssey*, Oct97, Vol. 6 Issue 7, p42, 1p, 1 chart; Reading Level (Lexile): 950; (AN 9710220531)
- ★ "Leonardo Pisano." *Encyclopædia Britannica*. 2008. Encyclopædia Britannica Online School Edition. 13 Oct. 2008 <<http://school.eb.com/eb/article-4153>>.

Additional Websites:

- ★ <http://www.mcs.surrey.ac.uk/Personal/R.Knott/Fibonacci/fibnat.html>
- ★ <http://www.mcs.surrey.ac.uk/Personal/R.Knott/Fibonacci/fibnat2.html>
- ★ http://nlvm.usu.edu/en/nav/frames_asid_133_g_4_t_3.html (an animation of the Golden Rectangle)

Books:

Adams, John A. Mathematics in Nature: Modeling Patterns in the Natural World. Princeton: Princeton University Press, 2003.



Step 3 – Create

- ★ Write the beginning sequence of the Fibonacci numbers. Make a list of objects in nature that have these numbers.
- ★ Explain the concept of the Golden Ratio or Phi and the resulting spiral patterns it forms. Make a list of objects in nature that have these spiral patterns.

Technology Link –

Use Geometer’s sketchpad to compare the dispersal of seeds using different ratios. Download a free trial of Geometer’s sketchpad at <http://www.keypress.com/x17670.xml> . Then, download the seed simulation at <http://www.mcs.surrey.ac.uk/Personal/R.Knott/Fibonacci/seed400.gsp> . (Save the file to your computer first. Then, open it with Geometer’s Sketchpad). Have students explore the seed dispersals at different degrees. Explain why Phi results in the best dispersal.

Step 4 – Discuss

Students should complete the following project:

- ★ Create a presentation that explains the Fibonacci sequence and the Golden Ratio. Identify where these patterns are observed in nature. Use a camera to photograph real-world examples of the Fibonacci sequence and the Golden Ratio.
- 🔗 Technology Link – Insert the photographs into a video editing program, such as Windows Movie Maker or iMovie. Add music, narration, text, and special effects to enhance the presentation.



Step 5 – Reflect

Allow students to present their projects to the rest of the class. Use the following suggested rubric to assess the students' work. Make sure that the students are familiar with the rubric *before* they begin creating their project. They should refer to the rubric repeatedly to monitor their progress in creating their project.

- 🔗 Technology Link: You can also create your own rubric with your students at <http://rubistar.4teachers.org/index.php>.

Presentation Rubric

| CATEGORY | 4 | 3 | 2 | 1 |
|---|--|---|---|--|
| Explanation of Fibonacci Sequence | Covers topic in-depth with details and examples. Subject knowledge is excellent. | Includes essential knowledge about the topic. Subject knowledge appears to be good. | Includes essential information about the topic but there are 1-2 factual errors. | Content is minimal OR there are several factual errors. |
| Explanation of Golden Ratio | Covers topic in-depth with details and examples. Subject knowledge is excellent. | Includes essential knowledge about the topic. Subject knowledge appears to be good. | Includes essential information about the topic but there are 1-2 factual errors. | Content is minimal OR there are several factual errors. |
| Examples of Fibonacci Sequence in Real World | Provides at least 8 photographs of the Fibonacci Sequence in the real world. | Provides 6-7 photographs of the Fibonacci Sequence in the real world. | Provides 4-5 photographs of the Fibonacci Sequence in the real world. | Provides 3 or less photographs of the Fibonacci Sequence in the real world. |
| Examples of Golden Ratio in Real World | Provides at least 8 photographs of the Golden Ratio in the real world. | Provides 6-7 photographs of the Golden Ratio in the real world. | Provides 4-5 photographs of the Golden Ratio in the real world. | Provides 3 or less photographs of the Golden Ratio in the real world. |
| Presentation | Well-rehearsed with smooth delivery that holds audience attention. | Rehearsed with fairly smooth delivery that holds audience attention most of the time. | Delivery not smooth, but able to maintain interest of the audience most of the time. | Delivery not smooth and audience attention often lost. |
| Attractiveness | Makes excellent use of font, color, graphics, effects, etc. to enhance the presentation. | Makes good use of font, color, graphics, effects, etc. to enhance to presentation. | Makes use of font, color, graphics, effects, etc. but occasionally these detract from the presentation content. | Use of font, color, graphics, effects etc. but these often distract from the presentation content. |