

Patterns and Fingerprints

Middle grades

Lesson Summary

In this activity, students apply the methods developed to identify and interpret patterns to the identification of fingerprints. They look at fingerprints of their classmates, snowflakes, and finally “spectral fingerprints” of elements. They learn to identify each image as unique, yet part of a group containing recognizable similarities.

Prior Knowledge & Skills

- Ability to recognize and describe patterns
- Experience interpreting data
- Visible light represents only a small portion of all light
- General understanding of energy

AAAS Science Benchmarks

The Nature of Mathematics

Patterns and Relationships

NSES Science Standards

- **Life Science:** Structure and function in living systems

NCTM Mathematics Standards

- **Geometry:** Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships
- **Algebra:** Understand patterns, relations, and functions

Suggested background reading

Fingerprint Identification

Teaching Time: One 60-minute period

Materials

Each group needs:

- Pencil or pen
- Index cards (1 per student)

To share with the class:

- Overhead copies of the student pages: Patterns In Nature, Numbers and Patterns, Sample Spectra
- Overhead copy of Fingerprint Fieldguide
- Master of Finger Print Field Guide
- Answer key for student pages, Patterns In Nature, Numbers and Patterns
- Photocopier
- Ink pad (2)

Advanced Planning

Preparation Time: 30 minutes

1. The day before the activity, create the Fingerprint Field Guide page and a set of anonymous fingerprints. Have each student make a thumbprint on the Fingerprint Field Guide page and write his or her name under the print. Create a set of anonymous fingerprints on index cards by having students imprint an index card when they add their print to the Fingerprint Field Guide. Number the index cards randomly.
2. Make one copy of the Fingerprint Field Guide for each student.
3. Copy the Fingerprint Field Guide and the anonymous prints on to overhead transparencies.
4. Copy Patterns in Nature, Numbers and Patterns, and Sample Spectra sheets on to overhead transparencies.

Why Do We Care?

A spectrum is the unique light signature produced by every element and molecule. Astronomers analyze spectra (spectroscopy) to figure out what stars, planets, moons and other astronomical objects are made of. In this activity, students practice identifying fingerprints using recognizable features (they may refer to the *Fingerprint Identification* reading for tips on how the pros do it, or develop their own system). This is analogous to how scientists analyze spectra.

Patterns and Fingerprints

Subject Areas geometry, life science, measurement, problem solving, reasoning & proof

Title Fingerprints

Grade Level 7 (6-8)

Activity Dependency

Time Required 60 minutes

Group Size 1 or 2

Expendable Cost per Group \$2.00

Summary

In this activity, students apply the methods developed to identify and interpret patterns to the identification of fingerprints. They look at fingerprints of their classmates, snowflakes, and finally “spectral fingerprints” of elements. They learn to identify each image as unique, yet part of a group containing recognizable similarities.

Keywords

Fingerprints, patterns, shapes, Pattern recognition, mathematical patterns, word puzzles, number puzzles

Educational Standards

Colorado State Standards

- Mathematics Standards 1, 2, and 4
- Life Science Standard 3.1

National Mathematics Standards

- Geometry: Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships
- Algebra: Understand patterns, relations, and functions

National Science Standards

- Life Science: Structure and function in living systems

Pre-Req Knowledge

- Ability to recognize and describe patterns
- Experience interpreting data
- Visible light represents only a small portion of all light
- General understanding of energy

Learning Objectives

After this activity, students should be able to:

- Describe the differences and similarities between patterns and fingerprints
- Identify fingerprints using pattern-identifying strategies

Materials List

Each group needs:

- Pencil or pen
- Index cards (1 per student)

To share with the entire class:

- Overhead copies of the student pages: *Patterns In Nature, Numbers and Patterns, Sample Spectra*
- Overhead copy of *Fingerprint Fieldguide*
- Master of *Finger Print Field Guide*
- Answer key for student pages, *Patterns In Nature, Numbers and Patterns*
- Photocopier
- Ink pad (2)

Introduction / Motivation

1. Display *Patterns in Nature* transparency on the overhead. Ask students to guess what each image might be. Then have the class discuss the clues they used to identify the images. Reveal the answer key on the overhead and point out how natural processes create organized geometrical patterns.
2. Display the *Numbers and Patterns* transparency. Give students a few minutes to figure out the puzzles, then ask members of the class for their answers.

Vocabulary / Definitions (optional)

Procedure

Before the Activity

1. **The day before the activity**, create the Fingerprint Field Guide page and a set of anonymous fingerprints.
 - a. Have each student make a thumbprint on the Fingerprint Field Guide page and write his or her name under the print.

- b. Create a set of anonymous fingerprints on index cards by having students imprint an index card when they add their print to the Fingerprint Field Guide.
 - c. Number the index cards randomly.
2. Make one copy of the Fingerprint Field Guide for each student.
3. Copy the “Fingerprint Field Guide” and the anonymous prints on to overhead transparencies.
4. Copy *Patterns in Nature, Numbers and Patterns*, and *Sample Spectra* sheets on to overhead transparencies.

With the Students

- Have the class place their desks in a large circle.
- Divide students into pairs and distribute to each team a copy of the Fingerprint Field Guide.
- Explain that you will pass out one index card to each group.
- Explain that students will try to match the numbered fingerprint to one of the prints on the Fingerprint Field Guide.
- Explain that students will have 1 minute (or choose another limit you think is appropriate) to make the identification and then they will pass the card to the team on their right. In this way, each team will have the same amount of time to identify each fingerprint on the index card.
- Circulate around the room as students work. Listen to their conversations and observe them work to understand the processes they use to identify the numbered fingerprints.
- Call a halt to the matching of the known prints to the numbered prints.
- Ask students to explain the processes that they used to help them match known and unknown prints. Make a list of methods and solutions students developed while trying to match numbered prints to named prints.
- Review the list and ask students to discuss or expand on the processes and identify which methods were most successful.
- As a class, review the prints and identify the owner of each numbered print. (Use the overhead transparency of the Fingerprint Field Guide to enlarge the images and look for details.)
- Ask students to compare the processes used identify patterns and fingerprints. What were the similarities and differences? How does recognizing a pattern compare to looking for unique characteristics? How are fingerprints alike and at the same time unique?

After the activity,

- Using the overhead projector, spectra images.
- For each image set, ask questions such as:
 - Do you recognize these images?
 - What can you tell me about the patterns?
 - Compare and contrast the images, what are some of the similarities and differences?
 - Are these examples of fingerprints or patterns?

- Point out that the images of colored bands are known as “spectral fingerprints” and that they represent the absorption and emission of energy by individual elements.
- Explain that like human fingerprints, spectral fingerprints are unique to each element and help scientists to identify the composition of many substances including mineral and gases.
- Bring closure to the lesson by asking students to summarize the similarities and differences between patterns and fingerprints in a graphic organizer such as a “T-chart” or Venn diagram. Encourage students to list how patterns and fingerprints appear and how they are used to help us understand the world around us.

Attachments

Patterns in Nature, Numbers and Patterns, Fingerprint Field Guide, Sample Spectra

Assessment

This lesson offers opportunities to assess students in many ways including but not limited to the following:

- Pattern recognition
- Verbalizing visual information
- Communicating complex ideas
- Identifying and interpreting patterns and sequences
- Logic and deduction

References

“NIEHS Kids Page: Brainteasers, Puzzles & Riddles.” April 27, 2004. The NIEHS Office of Management. March 4, 2005.

<<http://www.niehs.nih.gov/kids/braint.htm>>

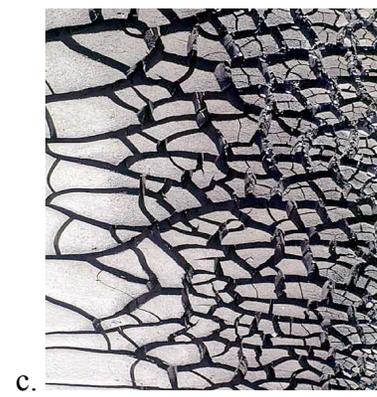
“Absorption Spectra.” Physics2000/University of Colorado. March 4, 2005.

<<http://www.colorado.edu/physics/2000/quantumzone/fraunhofer.html>>

Owner

Project SPECTRA!

Patterns In Nature



Answer Key and Sources
Part I: Patterns in Nature



Leaf with “spores?”

<http://www.drellenrudolph.com/patterns%20A/patternsA.html>

Summary of a talk presented at the 13th International Congress of the International Union for the Study of Social Insects, Adelaide, Australia, January 1999.



Sand Dunes

<http://www.drellenrudolph.com/patterns%20A/patternsA.html>

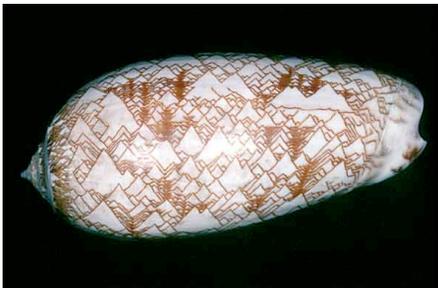
Summary of a talk presented at the 13th International Congress of the International Union for the Study of Social Insects, Adelaide, Australia, January 1999.



Mud cracks

<http://www.drellenrudolph.com/patterns%20A/patternsA.html>

Summary of a talk presented at the 13th International Congress of the International Union for the Study of Social Insects, Adelaide, Australia, January 1999.



Olive Shell

<http://www.drellenrudolph.com/patterns%20A/patternsA.html>

Summary of a talk presented at the 13th International Congress of the International Union for the Study of Social Insects, Adelaide, Australia, January 1999.

Numbers and Patterns

1) What is the next number in this sequence? _____

1, 1, 2, 3, 5,

2) What is the next, bottom, row in this triangle? _____

*1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1*

3) What is the next number in this sequence? _____

14, 91, 62, 53, 64,

4) Which letter comes next in the following sequence? _____

S, N, E, P, O, H, C

Numbers and Patterns

1) What is the next number in this sequence? _____

1, 1, 2, 3, 5,

Fibonacci Sequence

2) What is the next, bottom, row in this triangle? _____

1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1

Pascal's Triangle

3) What is the next number in this sequence? _____

14, 91, 62, 53, 64, ?

Answer: 96. They are the first few square number separated into sets of two digits, ie.
1 4 9 16 25 36 49 64... becomes 14 91 62 53 64 96...

Source: <http://www.braingle.com/brainteasers/index.php>

4) Which letter comes next in the following sequence? _____

S, N, E, P, O, H, C, _

Answer:

E.

Why? Each group of four consecutive letters, when read in reverse, form a word:

SNEP - pens

NEPO - open

EPOH - hope

POHC - chop

OHCE - echo

Source: <http://www.braingle.com/brainteasers/index.php>

Sample Spectra



Sample Spectra



Absorption spectra for hydrogen

<http://www-astronomy.mps.ohio-state.edu/~pogge/Ast162/Intro/Spectra/>



Emission spectra for helium

<http://www-astronomy.mps.ohio-state.edu/~pogge/Ast162/Intro/Spectra/>