Navigating through Geometry Grades 3-5

Presented by

Dr. Karol L. Yeatts

Navigations Writer

Navigating through Algebra Grades 3 5

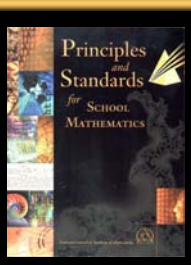
Navigating through Number and Operations Grades 3 5

Navigation Grade Level Specific Investigation Series

NCTM Academy Presenter

1

Principles and Standards for School Mathematics



Content Standards

Process Standards

Principles

2

Content Standards

- Number and Operations
- Algebra
- Geometry
- Measurement
- Data Analysis and Probability

3

Process Standards

- Problem Solving
- Communication
- Connections
- Representation
- Reasoning & Proof

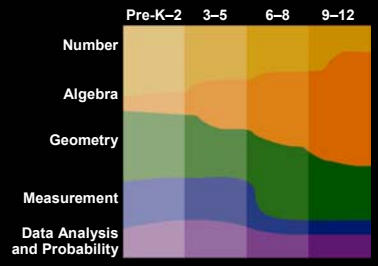
4

Principles

- Equity
- Assessment
- Teaching
- Learning
- Curriculum
- Technology

5

Emphasis across the Grades



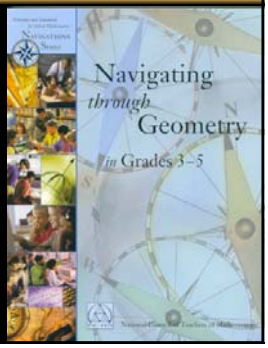
6

The Navigation Series

- An instructional resource for the implementation of the Principles and Standards
- Illustrative guide to the development of ideas in each of the content strands
- Tools to incorporate the instructional principles identified in the Standards
- A source of professional development content.

Navigating *through* Geometry in Grades 3-5

- Written by
  - M. Katherine Gavin
  - Louise P. Belkin
  - Ann Marie Spinelli
  - Judy St. Marie
- Editor
  - Gilbert J. Cuevas



Geometry Standard

Instructional programs from prekindergarten through grade 12 should enable all students to—

- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships
- Specify locations and describe spatial relationships using coordinate geometry and other representational systems
- Apply transformations and use symmetry to analyze mathematical situations
- Use visualization, spatial reasoning, and geometric modeling to solve problems

Table of Contents

- Chapter 1

Shapes

- Build What I've Created
- Thinking about Triangles
- Roping in Quadrilaterals
- Building Solids
- Searching for the Perfect Solids

Table of Contents

- Chapter 2

Location

- Find the Hidden Figure
- Xs and Os
- Can They Be the Same?

Table of Contents

- Chapter 3

Transformations

- Patchwork Symmetry
- Symmetry Detectives – Learn the Secret Code
- Going Logo for Symmetry!
- Tetrominoes Cover Up
- Motion Commotion
- Zany Tessellations

Table of Contents

- Chapter 4

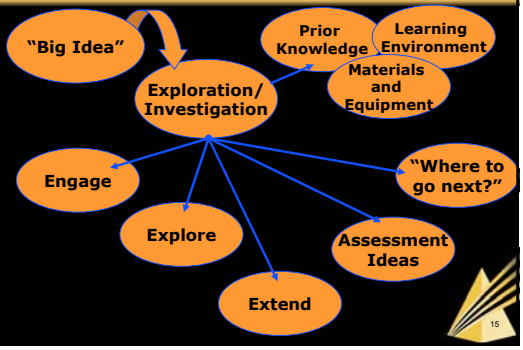
Spatial Visualization

- Puzzles with Pizzazz
- Exploring Packages
- It's All in the Packaging
- It's the View That Counts!
- Fraction Fantasy
- Geo City

Table of Contents

- Appendix
  - Black line Masters and Solutions
- CD ROM with Applets and Resources
  - Exploring Geometric Solids and their Properties
  - Geoboard
  - Isometric Drawing Tool
  - Pattern Patch
  - Shape Sorter
  - Tangram Challenge

Organization of Lessons

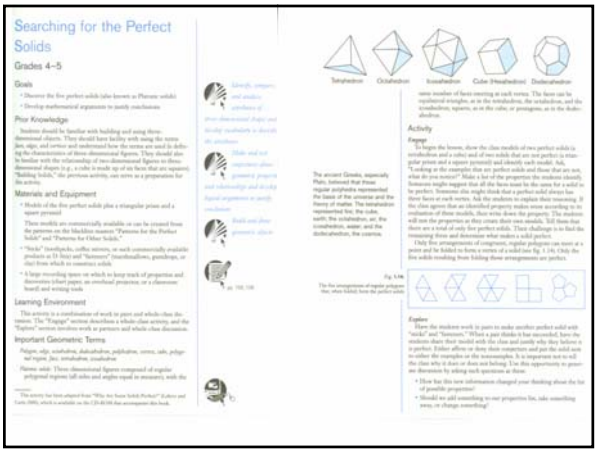


Searching for the Perfect Solids

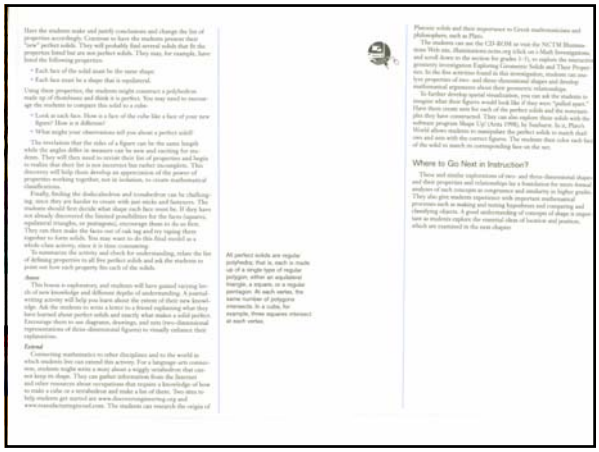
- How many Perfect Solids are there?
- What are the names of the Perfect Solids?
- Tell something that you know about Perfect Solids.

Searching for the Perfect Solids

- There are 5 Perfect Solids
- The names of the Perfect Solids are:
  1. Tetrahedron
  2. Octahedron
  3. Icosahedron
  4. Hexahedron (cube)
  5. Dodecahedron


Searching for the Perfect Solids

Grades 4–5



Searching for the Perfect Solids

- Goals
  - Discover the five perfect solids (Platonic Solids)
  - Develop mathematical arguments to justify conclusions.
- Prior Knowledge
  - Be familiar with three-dimensional objects and terms, faces, edges, and vertices
- Materials and Equipment
  - Models of the five perfect solids
  - Sticks and fasteners
  - BLM – Patterns for the Perfect Solids
  - CD-ROM - Exploring Geometric Solids and Properties

Searching for the Perfect Solids

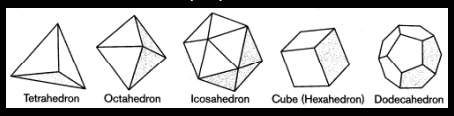
- Learning Environment
  - Combination of working in pairs and whole-class activities and discussions
- Important Geometric Terms
  - faces, edges, vertices, polygons, dodecahedron, polyhedron, cube, tetrahedron, icosahedron, octahedron, platonic solids
- Engage
  - Show the class the models of two perfect solids and two solids that are not perfect.

Searching for the Perfect Solids

- Explore
  - Have students work in pairs to make the other perfect solids.
  - Have students justify why they believe their solid is perfect.
- Assess
  - Have students write a letter to a friend explaining what they have learned about perfect solids.

Searching for the Perfect Solids

- Engage
  - Make a list of the properties of each solid.



- All perfect solids are regular polyhedra; that is, each is made up of a single type of regular polygon, either an equilateral triangle, a square, or a regular pentagon.
- At each vertex, the same number of polygons intersects.
- In a cube, for example, three square intersect at each vertex.

Exploring Geometric Solids and Properties CD-ROM Applet

Did you know that—
- Each solid has flat sides called *faces?*
- Each solid has *edges* to connect

Directions
- Choose a shape: Click on the New Shape button.
- Rotate the shape: Place the mouse pointer on the shape. Move the mouse while holding down the mouse button.
- Color the shape: Click on a color. Hold the shift key while clicking the mouse where you want to paint. You can paint a face in a color, an edge in white, or a corner in black. Remove the color: Click on the Reset Shape button.
- See through the shape: Click the box by Transparent.
- Change the size of the shape: Use the mouse to move

Xs and Os

- Goals
  - Locate points on a rectangular coordinate plane using ordered pairs.
  - Use the point of origin as a point of reference
  - Understand and use positive and negative integers to identify points in four quadrants.
- Materials
  - BLM – Coordinate Grids
  - Overhead projector and markers

25

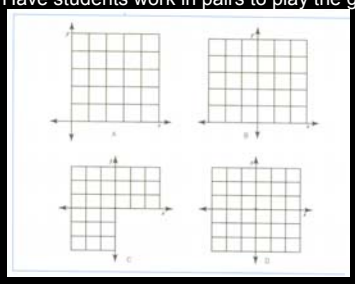
Xs and Os

- Engage
  - Play a game similar to tick tac toe.
  - Half the class will be X and the others O.
  - Display the coordinate grid on the overhead projector
  - One person from each group will tell you where to place an X or an O by naming the ordered pairs.

26

Xs and Os

- Extend
  - Have students work in pairs to play the game.

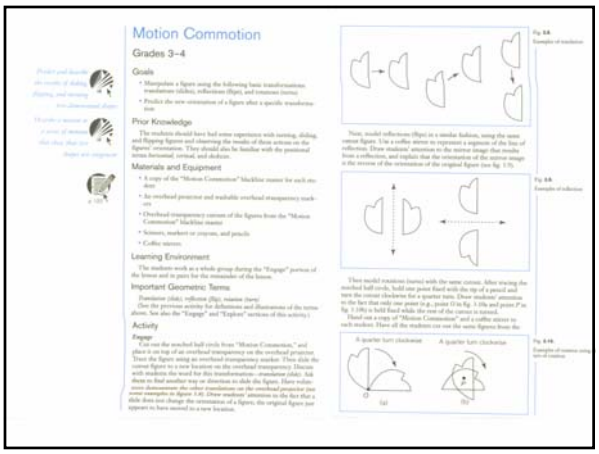


27

Motion Commotion

- Goals
  - Manipulative a figure using the following basic transformations:
    - Translations (slides)
    - Reflections (flips)
    - Rotations (turns)
- Materials
  - BLM- Motion Commotion
  - Overhead projector
  - Scissors, markers and pencils
  - Coffee stirrers

28



Motion Commotion

Grades 3–4

Goals

- Manipulate a figure using the following basic transformations: translations (slides), reflections (flips), and rotations (turns).
- Predict the new orientation of a figure after a specific transformation.

Prior Knowledge

The students should have had some experience with turning, sliding, and flipping figures and observing the results of these actions on the figures' orientation. They should also be familiar with the positional terms horizontal, vertical, and oblique.

Materials and Equipment

- A copy of the "Motion Commotion" blackline master for each student
- An overhead projector and washable overhead transparency markers
- Overhead transparency version of the figures from the "Motion Commotion" blackline master
- Scissors, markers or crayons, and pencils
- Coffee stirrers

Learning Environment

The students work as a whole group during the "Engage" portion of the lesson and in pairs for the remainder of the lesson.

Important Geometric Terms

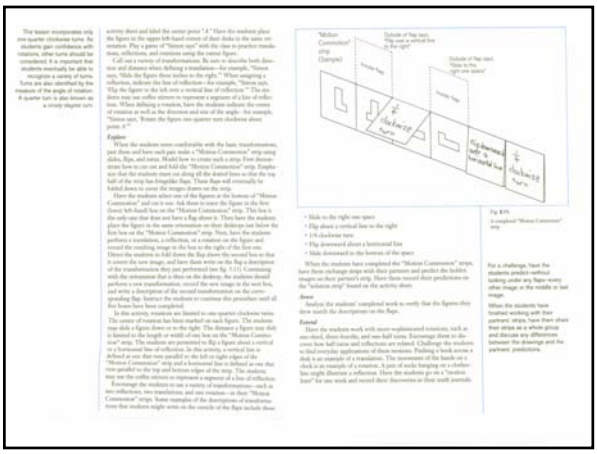
Translation (slide), reflection (flip), rotation (turn)

(See the previous activity for definitions and illustrations of the terms above. See also the "Engage" and "Explore" sections of this activity.)

Activity

Engage

Cut out the notched half-circle from "Motion Commotion," and place it on top of an overhead transparency on the overhead projector. Trace the figure using an overhead transparency marker. Then slide the cutout figure to a new location on the overhead transparency. Discuss with students the word for this transformation—*translation* (slide). Ask them to find another way or direction to slide this figure. Have volunteers demonstrate the other translations on the overhead projector (see some examples in figure 3.4). Draw students' attention to the fact that a slide does not change the orientation of a figure; the original figure just appears to have moved to a new location.



The lesson incorporates only one-quarter clockwise turns. As students gain confidence with rotations, other turns should be considered. It is important that students eventually be able to recognize a variety of turns. Turns are also identified by the measure of the angle of rotation. A quarter turn is also known as a ninety-degree turn.

activity sheet and label the center point "A." Have the students place the figure in the upper left-hand corner of their desks in the same orientation. Play a game of "Simon says" with the class to practice translations, reflections, and rotations using the cutout figure.

Call out a variety of transformations. Be sure to describe both direction and distance when defining a translation—for example, "Simon says, 'Slide the figure three inches to the right.'" When assigning a reflection, indicate the line of reflection—for example, "Simon says, 'Flip the figure to the left over a vertical line of reflection.'" The students may use coffee stirrers to represent a segment of a line of reflection. When defining a rotation, have the students indicate the center of rotation as well as the direction and size of the angle—for example, "Simon says, 'Rotate the figure one-quarter turn clockwise about point A.'"

Explore

When the students seem comfortable with the basic transformations, pair them and have each pair make a "Motion Commotion" strip using slides, flips, and turns. Model how to create such a strip. First demonstrate how to cut out and fold the "Motion Commotion" strip. Emphasize that the students must cut along all the dotted lines so that the top half of the strip has fingerlike flaps. These flaps will eventually be folded down to cover the images drawn on the strip.

Have the students select one of the figures at the bottom of "Motion Commotion" and cut it out. Ask them to trace the figure in the first (lower left-hand) box on the "Motion Commotion" strip. This box is the only one that does not have a flap above it. Then have the students place the figure in the same orientation on their desktops just below the first box on the "Motion Commotion" strip. Next, have the students perform a translation, a reflection, or a rotation on the figure and record the resulting image in the box to the right of the first one. Direct the students to fold down the flap above the second box so that it covers the new image, and have them write on the flap a description of the transformation they just performed (see fig. 3.11). Continuing with the orientation that is thus on the desktop, the students should perform a new transformation, record the new image in the next box, and write a description of the transformation on the corresponding flap. Instruct the students to continue this procedure until all five boxes have been completed.

In this activity, rotations are limited to one-quarter clockwise turns. The center of rotation has been marked on each figure. The students may slide a figure down or to the right. The distance a figure may slide is limited to the length or width of one box on the "Motion Commotion" strip. The students are permitted to flip a figure about a vertical or a horizontal line of reflection. In this activity, a vertical line is defined as one that runs parallel to the left or right edges of the "Motion Commotion" strip and a horizontal line is defined as one that runs parallel to the top and bottom edges of the strip. The students may use the coffee stirrers to represent a segment of a line of reflection.

Encourage the students to use a variety of transformations—such as two reflections, two translations, and one rotation—in their "Motion Commotion" strips. Some examples of the descriptions of transformations that students might write on the stretch of the flaps include those

- Slide to the right one space
- Flip about a vertical line to the right
- 1/4 clockwise turn
- Flip downward about a horizontal line
- Slide downward to the bottom of the space

When the students have completed the "Motion Commotion" strips, have them exchange strips with their partners and predict the hidden images on their partner's strip. Have them record their predictions on the "solution strip" found on the activity sheet.

Assess

Analyze the students' completed work to verify that the figures they drew match the descriptions on the flaps.

Extend

Have the students work with more-sophisticated rotations, such as one-third, three-fourths, and one-half turns. Encourage them to discover how half-turns and reflections are related. Challenge the students to find everyday applications of these notions. Pushing a book across a desk is an example of a translation. The movements of the hands on a clock is an example of a rotation. A pair of socks hanging on a clothesline might illustrate a reflection. Have the students go on a "motion hunt" for one week and record their discoveries in their math journals.

For a challenge, have the students predict—without looking under any flaps—every other image or the middle or last image.

When the students have finished working with their partners' strips, have them share their strips as a whole group and discuss any differences between the drawings and the partners' predictions.

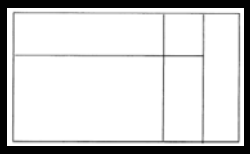
Puzzles with Pizzazz

- Goals
  - Practice mentally manipulating shapes
  - Develop strategies to solve visual logic puzzles
  - Combine shapes to create different shapes
- Materials
  - A variety of spatial-visualization and logic puzzles
  - BLM masters – Puzzles and Tangrams
  - CD-ROM – Tangrams

31

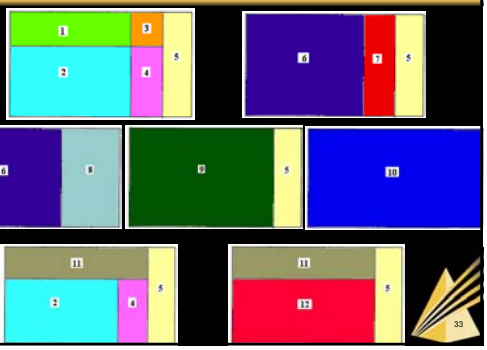
Puzzles with Pizzazz

How many rectangles are in the rectangle puzzle?



32

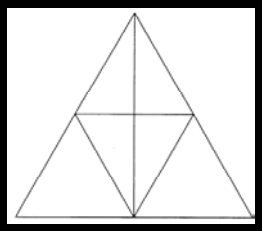
Solution



33

Puzzles with Pizzazz

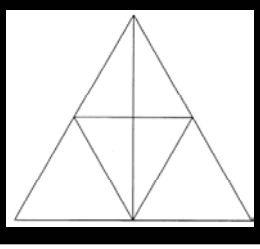
How many triangles are in the triangle puzzle?



34

Puzzles with Pizzazz

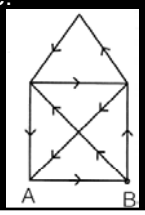
How many other shapes are in the triangle puzzle?

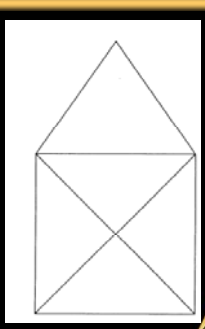


35

Puzzles with Pizzazz

Without lifting your pencil or retracing the lines, trace this figure.

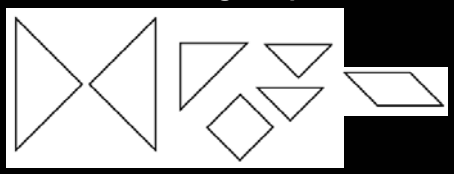




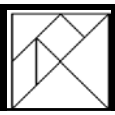
36

Tangram Puzzles with Pizzazz

Try to create a square using 1, 2, 3, 4, 5, 6, or 7 tangram pieces.

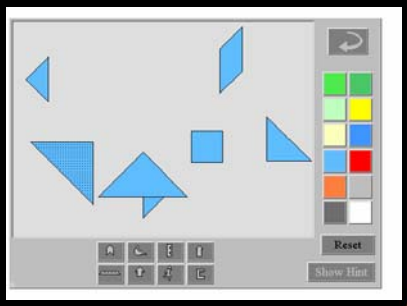


SOLUTION



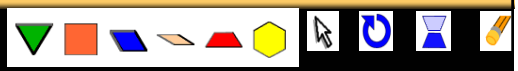
37

Tangram Challenges CD-ROM Applet



38

Pattern Patch CD-ROM Applet



- To begin, click on a shape to place them in the work space.
- The Slide, Turn, Flip, and Delete buttons can be used on any shape.
- Have the students examine the designs to see if they can rearrange the pattern blocks to find new shapes with five, six, or seven sides.
- They should record which blocks make up the new figure, trace around the new shapes, and verify the number of edges by counting the sides in the diagram.
- They can also discuss the number of angles in their diagrams and compare that number with the number of sides.

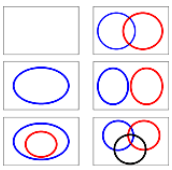
39

Shape Sorter CD-ROM Applet

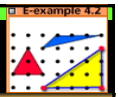
Students use the Shape Sorter applet to become familiar with the characteristics of quadrilaterals, including parallelograms, trapezoids, rectangles, rhombuses, and squares.

Click on and move the cursor into the work space. Place the figure in the in the diagram. A total of sixteen quadrilateral pieces are generated.

Use to select one of the following Venn diagrams.



Geoboard CĐ ROM Applet



Directions:

Click on the rubber-band box and drag a rubber band to the geoboard. Click on a node to attach one end of the rubber band to that node.

Discussion Questions:

- Is it possible for a triangle to have two right angles?
- How many different right triangles can be made on the geoboard?
- If you could make a triangle that was as large as you wanted, would you be able to make one that had two right angles?
- Write everything you know that is true about all right triangles.
- Write in your own words the definitions for the new geometric terms we have found (isosceles, scalene, acute, and obtuse).

Additional CD-ROM Resources

- Templates
- Puzzle Sets
- Students' Tessellation Art
- Articles

42