Investigating "Ominoes"
A Learning Continuum from Kindergarten to Grade 6

Kindergarten

Tasks

Provide these instructions to the children:

a) Start by using two coloured tiles. Make as many shapes as you can with two tiles. Each time you make a new shape, cut the same shape out of grid paper. Make sure your cut-out shape matches your coloured tile shape. Describe your shapes using mathematical language, like this: "I made this shape by putting the second square on top of the first one."

b) Now make as many different shapes as you can using three coloured tiles. Each time you make a new shape, cut it out of grid paper. Describe your shapes using math language.

c) Collect all of your shapes, then find a way to sort them. Tell about how you sorted your shapes.

d) Collect the shapes again and find a different way to sort them. Tell about how you sorted your shapes.

Tools to Choose From

- coloured tiles
- grid paper (to match the size of the coloured tiles)
- scissors
- hoops or yarn for sorting

Expectations

Students will

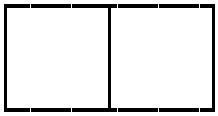
- use language to accurately describe basic spatial relationships (e.g., above/ below, near/far, in/out) (KM19)
- sort and classify objects into sets according to specific characteristics, and describe those characteristics (e.g., colour, size, and shape) (KM8)

Teacher Notes

Use masking tape to make a large grid on the floor or on a large plastic sheet. Have one student pick a spot on the grid. Another student then stands on an adjoining square. Have the class describe where the second student is standing with respect to the first student (e.g., Joe is beside Sally). Now have the second student choose a different adjoining square to stand on. (The first student remains in his or her original position.) Again, have the class describe the position of the second student in relation to the first. This activity could be repeated several times using different students and different starting spots on the grid.

Students then begin to use grid paper and coloured tiles. (Have the students begin with two coloured tiles.) As in the previous activity, the students keep one coloured tile static while moving the other one to create the shapes. To record the shapes they have created, students cut them from a piece of grid paper. If some children are unable to do the cutting, provide pre-cut shapes, and allow the students to select the shape that matches the one they created. After initial experimentation, have students point out the shapes where the squares are joined on one full side, such as the one below.

The squares can go together like this.



Once students have created as many shapes as they can with two tiles, they can begin to make shapes on the grid using three tiles. Again, ask the children to create as many shapes as possible, to record the shapes using grid paper, and then to describe their shapes using mathematical language.

These activities will likely take more than one day to complete. Once students have created, sorted, and described their shapes using two and three coloured tiles, have them sort the shapes in different ways.

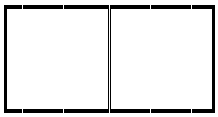
Grade 1

Task

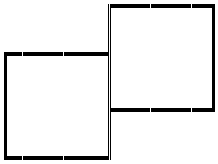
Make and draw as many different tetrominoes (geometric shapes made with four squares) as you can. Show that you have found all of them.

Note these examples:

The squares can go together like this



The squares **cannot** go together like this



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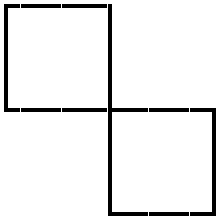


Tools to Choose From

- coloured tiles
- grid paper
- Cube-a-links with matching 2-cm grid paper
- Polydron™(squares only)
- Polydron Frameworks™
- overhead grid paper
- scissors

Expectations

Students will

- compare the size and shape of two-dimensional shapes by superimposing (1M76)
- understand basic concepts in transformational geometry using concrete materials and drawings (1M65)

Teacher Notes

The students will probably make the same tetromino shape two or more times without realizing that it is the same shape un a different position (flipped or turned). Ask probing and prompting questions that will encourage the students to superimpose the shapes; then ask again if they are the same. For example, you might ask

a) How are these shapes different?
b) How are they the same?
c) What parts of the shapes give you clues about whether they are the same or different?
d) What might you do with the shapes to find out?

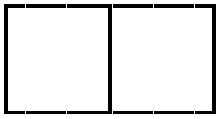
Grade 2

Task

Make and draw as many different tetrominoes as you can. Show that you have found all of them. Explain your thinking using math language (e.g., edges, vertices, flips, slides, turns).

Note these examples:

The squares can go together like this



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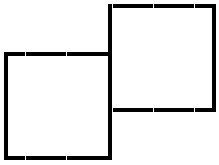

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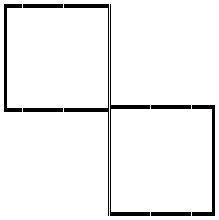


Tools to Choose From

- coloured tiles
- grid paper
- Cube-a-links with matching 2-cm grid paper
- Polydron™(squares only)
- Polydron Frameworks™
- overhead grid paper
- scissors

Expectations

Students will

- vertices (2M73)
- demonstrate transformations such as flips, slides, and turns using concrete materials (2M78)

Teacher Notes

The students will probably make the same tetromino shape two or more times without realizing that the shape has simply been flipped or turned. Ask probing and prompting questions that encourage the students to superimpose the shapes; then ask again if the shapes are the same. For example, you might ask

a) How are these shapes different?
b) How are they the same?
c) What parts of these shapes give you clues about whether they are the same or different?
d)What might you do with the shapes to find out?

Each student (or pair of students) can get together with another student (or pair of students) to share results. This sharing promotes the development of mathematical language and the understanding of the transformation geometry. When students must convince one another, their understanding of the concept is strengthened.

Going Beyond

a) Which tetrominoes have a line of symmetry?
b) Use five squares to find all the pentominoes.
c) Use three different tetromino shapes to make as many different figures as you can with fewer than ten sides.

Grade 3

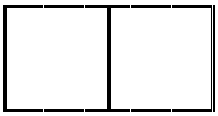
Task

Create all five tetrominoes.

a) Create a set of tetrominoes.
b) Look at each tetromino. Which tetrominoes are symmetrical? How do you know? Show your thinking.
c) Which tetrominoes can be combined to create a rectangle? Record your ideas on square grid paper.
d) Is it possible to create a 4x4 square with tetrominoes? Record your ideas on square grid paper. Show your thinking.
e) Place a tetromino on a square grid. Imagine that it is the shape of a park. Describe the path around it.
f) Describe the path around another tetromino. Have your partner identify the shape of the tetromino

Note these examples:

The squares can go together like this



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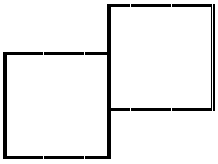

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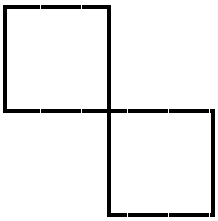


Tools to Choose From

- coloured tiles
- square grid paper on manilla tag paper
- Cube-a-links with matching 2-cm grid paper
- Polydron™(squares only)
- Polydron Frameworks™
- overhead square grid paper
- scissors
- Mira™ or plastic mirrors

Expectations

Students will

- perform rotations using concrete materials (e.g., quarter-turn, half-turn, three-quarter turn) (3M75)
- describe how to get from one point to another on a grid (e.g., two squares right followed by one square up) (3M76)
- solve two-dimensional geometric puzzles (3M71)
- determine lines of symmetry for two-dimensional shapes using paper folding and reflections in a transparent mirror (3M73)
- identify transformations such as flips, slides, and turns using concrete materials and drawings (3M74)

Teacher Notes:

Begin this activity by asking a question such as, "How do you think a tetromino different from a domino or a triomino?" (i.e., domino – 2 square units; triomino – 3 square units; tetromino – 4 square units). Have the students create a domino and a tetromino using colour tiles, interlocking cubes, or Polydron™ squares.

Tell the students that there are five different tetrominoes. Ask a question like, "How do you know that you have five different tetrominoes." Have the students create the five different tetrominoes using colour tiles, interlocking cubes, or Polydron™ squares. Once the students have identified the five different tetrominoes, have them cut them out on square grid paper. Use 2-cm grid paper.

Discuss the idea of symmetry, using a domino and a triomino. Ask questions such as, "How do you know that these shapes are symmetrical? What ways can we prove that these two shapes are symmetrical?" Students could demonstrate symmetry, using plastic mirrors and/or Miras™ and through paper folding.

Your next question could be, "What different shapes can be made with tetrominoes?" Have the students record their ideas on a class chart with the column headings: # of Tetrominoes, Shape Description, Number of Lines of Symmetry...

Tell the students to imagine that that each tetromino is a possible shape for a park. If you have square tiles in your classroom, outline a tetromino on the square tiles and have the students describe the path taken around the tetromino. Be sure to mark the starting point.

Have the students describe the paths of different tetrominoes on square grid paper with their tetromino paper models. Have the students record their walking route using arrows.

Grade 4

Task

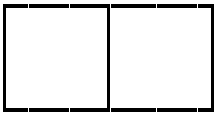
Pentominoes are two-dimensional shapes composed of 5 square units.

How many different pentominoes are there?

a) How do you know that you have all of the different pentominoes? Explain your thinking using mathematical language.
b) Estimate the perimeter of each pentomino. Describe the relationship between the perimeter and area of the set of pentominoes.

Note these examples:

The squares can go together like this



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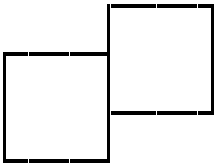

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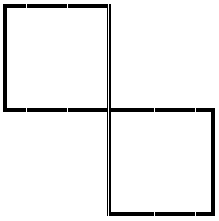


Tools to Choose From

- coloured tiles
- grid paper
- Cube-a-links with matching 2-cm grid paper
- Polydron™(squares only)
- Polydron Frameworks™
- overhead grid paper
- scissors

Expectations

Students will

- recognize mathematical relationships in patterns (e.g., the second term is two more than the first, the second shape is the first shape turned through 90°) (4M90)
- understand that different two-dimensional shapes can have the same perimeter or the same area (4M52)
- use mathematical language to describe geometric ideas (e.g., line, angle) (4M77)
- demonstrate an understanding of translations, reflections, and rotations (4M81)

Teacher Notes

The students will probably make the same pentomino shape more than one time without realizing that the shape has simply been flipped or turned. Ask probing and prompting questions that encourage the students to superimpose the shapes to assist students in finding all of the pentomino shapes; then ask again if the shapes are the same. For example, you might ask:

a) How are these shapes the same?
b) How are these shapes different?
c) What parts of these shapes give you clues about whether they are the same or different?
d) What strategy would you use to find out if the shapes are the same or different?
e) How do you know you have found all of the pentomino shapes?

Each student (or pair of students) can get together with another student (or pair of students) to share their results. This sharing promotes the development of mathematical language; it assists the students in improving their articulation of the strategies used to solve the problem, and the understanding of transformational geometry. When students must convince one another they are better able to explain and justify the strategy used to solve the problem, and their understanding of the geometric concept is strengthened.

Going Beyond

a) Which pentominoes have a line of symmetry?
b) Do any pentominoes have more than one line of symmetry?
c) Use three different pentomino shapes to make a figure with the least amount of sides and/or the greatest amount of sides.

Grade 5

Task

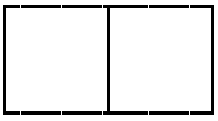
Hexominoes are two-dimensional shapes composed of 6 square units.

Record all the different hexominoes on square grid paper.

a) Estimate the perimeter of a few different hexominoes. Explain your estimation method(s).
b) Decide if predictions about the perimeter of different hexominoes can be made. Explain your thinking.
c) Predict which hexominoes can be folded into a cube. Show your work using models.

Note these examples:

The squares can go together like this



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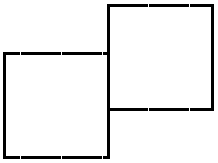

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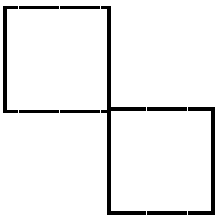

Tools to Choose From

- coloured tiles
- grid paper
- Cube-a-links with matching 2-cm grid paper
- Polydron™(squares only)
- Polydron Frameworks™
- overhead grid paper
- scissors

Expectations

Students will

- identify nets for a variety of polyhedra from drawings while holding three-dimensional figures in their hands (5M71)

- develop methods of using grid paper to track and measure the perimeter and area of polygons and irregular two-dimensional shapes (5M58)

Teacher Notes

The students will probably make the same hexomino shape more than one time without realizing that the shape has simply been flipped or turned. Ask probing and prompting questions that encourage the students to superimpose the shapes to assist students in finding all of the hexomino shapes; then ask again if the shapes are the same. For example, you might ask:

a) How are these shapes the same?
b) How are these shapes different?
c) What parts of these shapes give you clues about whether they are the same or different?
d) What strategy would you use to find out if the shapes are the same or different?
e) How do you know you have found all of the hexomino shapes?

Each student (or pair of students) can get together with another student (or pair of students) to share their results. This sharing promotes the development of mathematical language; it assists the students in improving their articulation of the strategies used to solve the problem, and the understanding of transformational geometry. When students must convince one another they are better able to explain and justify the strategy used to solve the problem, and their understanding of the geometric concept is strengthened.

Going Beyond

a) Which hexominoes have a line of symmetry?
b) Do any hexominoes have more than one line of symmetry?
c) Use three different hexomino shapes to make a figure with the least amount of sides and/or the greatest amount of sides.

Grade 6

Task

See attached investigation and answer key.

Tools to Choose From

- coloured tiles
- grid paper
- Cube-a-links with matching 2-cm grid paper
- Polydron™(squares only)
- Polydron Frameworks™
- overhead grid paper
- scissors

Expectations

Students will

- pose and solve problems by recognizing a pattern
- visualize and describe the effect of translations, reflections, and rotations
- explain, make conjectures about, and articulate hypotheses about geometric properties and relationships

Teacher Notes

To initiate this lesson, the students must investigate the problem stating with a single square tile. To create a domino, they should note that it is a simple matter to set a second tile next to the first so that they touch full edge to full edge, Now they can take a domino to create triominoes. They should discover that all (2) triominoes can be created using a domino as a base. Either a third tile is set adjacent to the end (the short side) of the domino to form three tiles in a row or a tile is set adjacent to one of the domino tiles to form an "L" shape. The key part of the lesson happens at this point. Using the two distinct triominoes, tetrominoes can be formed by adding a tile. Students should discover the following:

a) at least one tetromino can be created from either triomino,

and some are unique, and

c) the set of all tetrominoes are generated using either triomino.

This is the basis of this investigation as students now move from tetrominoes to pentominoes and so on. The key learning centers around making observations, stating conjectures, and determining strategies to test conjectures. Problem solving can certainly be assessed as the students carry out this investigation.

Many grade 6 expectations in the Geometry and Spatial Sense strand are addressed. Depending upon the nature of the "what if" questions generated by the students, expectations in Patterning and Measurement are also addressed.