



MILES of TILES



Lesson Plan

KINDERGARTEN

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A Letter from the PSEG Foundation

My fascination with energy started at a young age.

The Arab oil embargo of the 1970's sent gasoline prices through the roof and made clear how closely tied our country's foreign policy is to oil interests. I began wondering whether we could produce energy in ways that didn't involve oil, and I wanted to be part of the quest to find the answer.

That passion led me to pursue years of study in the fields of physics and engineering. Graduate degrees in those areas allowed me to take on a variety of fascinating assignments in my career. I served as a research scientist at the Princeton Plasma Physics Lab, a Congressional Science Fellow in the office of U.S. Senator Bill Bradley, and a science, energy, and technology policy advisor to Governor Tom Kean before coming to PSEG where I work every day to create and deliver power responsibly.

This curriculum, developed by the Museum of Mathematics and funded by PSEG, is intended to help young people develop an interest in math and the technical fields—to spark curiosity, stimulate inquiry, and help students down a path of discovery that leads to fulfilling careers.

As issues such as climate change, energy independence, and national security demand increasingly comprehensive and technical solutions, the need for people with knowledge in science, technology, engineering, and math—areas known as the STEM subjects—will continue to grow.

At PSEG, we understand that our country's future depends on developing the insights, creativity, and dynamism of the next generation of innovators. This curriculum is one of many investments we've made in an effort to help young people discover their talents and develop a thirst for knowledge.

A math- and science-savvy workforce will lead the way to innovative technological discovery, a strengthened economy, and thriving new industries. And it is an important part of building a talent pipeline for the energy industry and our country as a whole.

Ralph Izzo
Chairman, CEO and President, PSEG

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General Instructions for *Math Midway 2 Go*

Math Midway 2 Go (MM2GO) consists of six interactive mathematics exhibits that can travel to schools and other venues. Hands-on activities captivate and engage students, highlighting the wonder of mathematics. These exhibits were designed for use with individuals of all ages, and the mathematical topics they address range from topics in the elementary classroom to college-level mathematics. Students of all ages will benefit from open exploration of the exhibits. At the same time, the exhibits also tie into specific curricular topics for kindergarten through grade 12.

These lesson plans are provided by MoMath to support teachers like you. To help you and your students make the most of your time at *Math Midway 2 Go*, a focus exhibit has been selected for each grade from kindergarten through grade 12. The Kindergarten focus exhibit is *Miles of Tiles*.

MM2GO is designed to accommodate one class of up to 36 students at a time.

It is ideal to have only a small group of students at each exhibit while visiting *Math Midway 2 Go*. Break your class into six groups and have them rotate through the exhibits, with one group at each exhibit at a time. Before starting, make sure that students understand basic rules for interacting with the exhibits:

- ★ Walk in the area surrounding the exhibits; don't run.
- ★ Handle the exhibits gently.
- ★ Do not hang or lean on the *Number Line Tightrope*.
- ★ Handle *Ring of Fire* shapes gently.

Ideally, school support staff and/or parent volunteers will be available for the duration of the visit to *Math Midway 2 Go*. These adults can circulate throughout the exhibits, while the classroom teacher remains at the focus exhibit. At the five exhibits that are not the grade-level focus, students can explore and play.



Information about *Miles of Tiles*

About the exhibit:

Miles of Tiles is a magnet wall with various magnetic tile shapes—triangles, squares, hexagons, two types of rhombuses, and monkeys. As students play, they can explore many aspects of shape and pattern, observing how various tiles fit together. Note that *Miles of Tiles* is designed in particular to help students explore **tessellations**: patterns of tiles with no gaps and no overlaps, that could extend to cover the entire plane. Each of the shapes tessellates by itself, including the irregularly shaped monkeys, which most people find surprising. Some shapes will also tessellate in combination with other shapes (rhombus and square), whereas other combinations of shapes (square and hexagon) do not tessellate.

Why visit *Miles of Tiles*?

Miles of Tiles is a magnetic wall that students can cover with patterns and shapes. The exhibit is intuitive (people of all ages immediately play with it) and lends itself to great discussions about shapes.

Early learners are just beginning to learn how to describe and name shapes. *Miles of Tiles* presents a fun, interactive way for them to explore shape names and shape descriptions, while at the same time exploring how shapes fit together. *Miles of Tiles* features the following shapes: triangles, squares, rhombuses, and hexagons, along with the monkey magnets. Exploring these colorful and fun magnets will support students' knowledge of shapes.

In addition, while describing and naming shapes, students will practice their counting skills, counting both corners and edges of the shapes they see.





Integrating MM2GO Into Your Unit Plans

Consider the following key questions, class topics, and elements of the Common Core State Standards when considering how to link *Miles of Tiles* to the study of mathematics taking place in your classroom.

Key questions inspired by *Miles of Tiles*:

- ★ What parts of a shape can be counted? What parts do all shapes have? How can counting help us name a shape?
- ★ What happens when shapes are combined?
- ★ If I am trying to combine magnets to make a particular new shape, how can I make a plan to lay out the magnets, based on the shapes of the individual magnets that I have available?

This lesson plan will be useful with the following classes:

- ★ Classes in which students are learning to count and getting a sense for equality
- ★ Classes beginning to explore shapes and properties of shapes
- ★ Classes learning about comparing numbers and quantities

Relevant connections to the Common Core State Standards:

Learning Standards

K.CC: Count to tell the number of objects.

K.G: Identify and describe shapes.

Standards for Mathematical Practice

- ★ Make sense of problems and persevere in solving them.
- ★ Reason abstractly and quantitatively.
- ★ Construct viable arguments and critique the reasoning of others.
- ★ Model with mathematics.
- ★ Look for and make use of structure.
- ★ Look for and express regularity in repeated reasoning.



Miles of Tiles Pre-Activity

Description

In this activity, students will explore pattern blocks or other small shapes to count corners and edges and name the shapes they see.

While this activity is designed for use before visiting *Miles of Tiles*, the activity can be enjoyed independently of a visit from the Museum of Mathematics' *Math Midway 2 Go*.

Materials

- ★ Classroom set of pattern blocks, or other geometric shapes that students can play with.
- If you do not have access to pattern blocks, you can print the attached template on card stock. These paper pattern blocks were created using NCTM's Dynamic Paper applet (<http://illuminations.nctm.org/ActivityDetail.aspx?ID=205>), which allows teachers to create their own graphics.

Key Terminology

- ★ **Shape**
- ★ **Size**
- ★ **Same**
- ★ **Different**
- ★ **How many?**
- ★ **Corner**
- ★ **Side**

Conducting the Activity

1. Seat students around small tables or in circles on the floor, and give each student a handful of pattern blocks. Give students some time to play freely with the pattern blocks. As they play, walk around and encourage them to make patterns on the table or floor and to identify the individual blocks as the same or different. Towards the end of free play time, gather the students together and encourage them to share their creations with their classmates.
2. Hold up one of the pattern block shapes—a triangle. Ask students: do you have a shape that is the **same** as this shape? Ask students to hold up a shape that they believe is the same.
3. Ask students, how do you know that the shapes are the same? Take some ideas—encourage the use of terms like **shape** and **size**. Students may also suggest color.



Miles of Tiles Pre-Activity (Continued)

4. Now, hold up two shapes that are different—a square and a triangle. Ask students to hold up a square, too. Ask students: are these shapes the same? How do you know that they are **different**? Take some ideas.
5. Explain to students that when we want to see if two shapes are the same or different, it is sometimes helpful to ask “**how many?**” questions about them and then count. Hold up the two different shapes—a square and a triangle. Ask students if they see anything that can be counted. When a student suggests a part of the shapes to count, rephrase that as a “**how many?**” question, like “How many corners does this shape have?”
6. Touch your finger to the **corners** of the shape and ask the students to do the same. Explain that these are the **corners** of the shape. Hold up the triangle. How many corners does it have? Hold up the square. How many corners does it have? Do these two shapes have the same number of corners?
7. Run your finger along the **sides** of a shape and ask the students to do the same. Explain that these are the **sides** of the shape. Hold up the triangle. How many sides does it have? Hold up the square. How many sides does it have? Do these two shapes have the same number of sides?
8. Now ask students: if two shapes have different numbers of sides and corners, can they be the same? Explain to students that we can always count corners and edges to see if shapes are the same or different.
9. Next, hold up the square and the trapezoid. Show students the trapezoid and ask them to hold up one from their pile of shapes. Ask students, how many corners does it have? How many sides does it have? Does it have the same number of sides and corners as the square?
10. These shapes have the same number of corners and the same number of sides. Ask students, are they the same? What about them is the same? What about them is different?



Miles of Tiles Pre-Activity (Continued)

11. Now ask students, if two shapes have the same numbers of sides and corners, are they definitely the same? What else about them could be different?
Students may have difficulty verbalizing possible differences. This question can be skipped if you deem it inappropriate for your class. Students will learn the difference between square and trapezoid more formally later in elementary school. For now, saying that one side is longer or they look different is an appropriate response.

12. You can now send students to stations or centers in which they will work with these ideas. Here are some ideas for teacher-guided and independent centers that you may wish to use:

Teacher-Guided Centers:

- ★ Reinforce counting corners and sides, and teach some shape names. Students should have their own handfuls of pattern blocks. A teacher can hold up a shape and ask students to find the same shape in their pile of blocks. The teacher can then ask students to count the corners and sides. The teacher can share the name of the shape. Once some shapes have been counted and named, the teacher can ask students to find particular kinds of shapes—for example, students could look for a shape with four sides, a shape with three corners, a square, or any other descriptions the teacher chooses.
- ★ Build new combined shapes using the pattern blocks, and count their sides and corners. The teacher can give the students some time to build a new shape by taking a few pattern blocks and adjoining them to each other. The teacher should take some time to practice with students how to slide the shapes together so their edges match. Once students have a bigger shape made of a number of pattern blocks, students can share their new shapes. The teacher should ask the following questions about the shapes: How many corners do they have? How many sides? The teacher should stress that the corners and edges are found only on the outside of the new, bigger shape.



Miles of Tiles Pre-Activity (Continued)

- ★ If students find this too challenging, the teacher can provide more explicit direction, such as asking students to use only triangles or squares, asking students to use only two shapes, or asking students to make a shape with a given number of sides or corners.

Independent Centers:

- ★ Students can build common objects on the table using pattern blocks. Can they make a design that looks like an animal? How about one that looks like their house or furniture? What about objects they see in the room? Describe the task to the students before they go to the center, and leave a pictorial and written reminder of the task for them to reference. If an adult is available, s/he can take pictures of the creations and later hang them in the room.
- ★ Free play. Encourage students to build flat designs that have no gaps in them. Describe the task to the students before they go to the center. If an adult is available, s/he can take pictures of the creations and later hang them in the room.

Extension: Repetition, Repetition

Repeat these tasks with students throughout the following week. Additional exposure to the terms and ideas students have been exploring with their pattern blocks will lead them to master shape names and gradually improve their design skills.



Miles of Tiles Activity

Description

In this activity, students will explore *Miles of Tiles*, using the tiles to make patterns and describing the shapes they are using.

Materials

- ★ There are no special materials required for this activity, other than the exhibit itself.

Key Terminology

- ★ Shape
- ★ Same
- ★ Different
- ★ How many?
- ★ Corner
- ★ Side

Conducting the Activity

1. Give the students some time to freely explore the exhibit.
2. After about five minutes, gather the students together. Ask them to describe *Miles of Tiles*. What were they doing at the exhibit? What did they notice about the magnets?
3. Ask students if they recognize any of the shapes they saw. Did they see any shapes with three sides? Four sides? More? Three corners? Four corners? More? When a student describes a shape, ask him or her to hold one up and show it to the group.
4. Go through all of the different shapes in *Miles of Tiles*, counting their sides and corners. Each time a student holds up a shape, ask students if it is the same or different from the shapes you have already counted. Ask them to explain their thoughts.
5. Discuss the monkey magnet. Ask students – what is different about the sides of the monkey? Explain to students that curved or rounded sides are harder to count, so for now we will not count the sides and edges on the monkey.



Miles of Tiles Activity (Continued)

6. With remaining time, challenge students to imagine a design they will make on the magnet wall. The design they decide to tackle could be anything—a person made out of magnets, an animal made out of magnets, an object made out of magnets, or an abstract pattern. Leave your students time to use the magnets to make their designs on the *Miles of Tiles* magnet wall.



Miles of Tiles Post-Activity

Description

In this activity, students will continue exploring shapes via the following activities: naming shapes, designing with shapes, and completing shape puzzles.

While this activity is designed for use after visiting *Miles of Tiles*, the activity can be conducted with students who have not had the opportunity to experience the Museum of Mathematics' *Math Midway 2 Go*. Make sure that students already have experience describing and naming shapes and making designs with them.

Materials

- ★ Copies of the *Shape Puzzles!* sheets; you will need at least one copy of each puzzle
- ★ Pattern blocks
If you do not have access to pattern blocks, you can print the attached template on card stock. These paper pattern blocks were created using NCTM's Dynamic Paper applet (<http://illuminations.nctm.org/ActivityDetail.aspx?ID=205>), which allows teachers to create their own graphics.

Key Terminology

- ★ Shape
- ★ Same
- ★ Different
- ★ How many?
- ★ Corner
- ★ Side
- ★ Triangle
- ★ Square

Conducting the Activity

1. Gather students together. Ask them what they remember from the *Miles of Tiles* exhibit. What did they do? What was exciting and fun? Did they find anything tricky?
2. Ask students, what kinds of shapes were there at the *Miles of Tiles* exhibit? Have students describe the shapes according to the numbers of sides and corners as well as other qualities students suggest.
3. Explain to students that the shapes in the pattern blocks set are almost exactly like the shapes in the *Miles of Tiles* exhibit. Point out the red trapezoid and white rhombus—those are two pattern block shapes that are missing from *Miles of Tiles*. Are they the only pattern blocks that don't show up as tiles in *Miles of Tiles*?



Miles of Tiles Post-Activity (Continued)

*For your reference, the white rhombus in the pattern block set is close in shape to the red rhombus in the **Miles of Tiles** set, but it is **not** a scaled down version of the red rhombus; these two different rhombuses have different interior angles. However, your students will likely focus more on the colors than the angles of these rhombus tiles. Similarly, while they appear closely related, the **Miles of Tiles** blue rhombus and the pattern block blue rhombus have different interior angles, so the pattern block is not a scaled-down version of the blue **Miles of Tiles** rhombus. Again, it is unlikely that kindergarten students will notice this slight difference.*

4. Now, hold up a triangle. Have students point out the triangle's three corners and sides. Tell students that a shape with three corners and three sides is called a **triangle**.
5. Next, hold up a square. Have students point out the square's four corners and sides. Tell students that this shape is called a **square**.
6. Display the other shapes for students to see. Ask, can you find another shape with four corners and four sides that is different from the square? Have students come up and hold out the shapes they see that are different, but also have four corners and four sides.
7. Hold up all of these different shapes, which may include the trapezoid and both of the rhombuses. Ask students: how are they different from the square? Students may point out that the corners are different, the sides are tilted differently, that the red shape has one side that is longer, and that the colors are different. If students raise color as a different quality, ask them whether they think the color matters to the shape of the object. If you painted the red shape and made it orange, would it be the same shape as the orange square?



Miles of Tiles Post-Activity (Continued)

8. Explain to students that just because a shape has four sides and four corners does not make it a square. But a square has to have four sides and four corners, and must look like the orange square they are holding up.

The goal here is to plant the seed for more formal comparison of shapes in later grades.

9. You can now send the students to centers or stations where they will work on these ideas. Here are some ideas for teacher-guided and independent centers that you may wish to use:

Teacher-Guided Centers:

- ★ Reinforce the difference between a square and other shapes with four sides and four corners. Have students point out the similarities and differences between the square, trapezoid, and two rhombuses. Then ask, if you were trying to tell a person who didn't know what a square was to pick the square out of the pile of pattern blocks, how would you describe it? Develop a description that applies only to the square.
- ★ Explore why shapes with four (or some number) of corners must have the same number of sides. Give the students a pile of pattern blocks and ask them to make a bigger shape by putting pattern blocks next to one another. Ask each student to count the number of corners and sides in their overall shape. Is the number of corners larger than, smaller than, or the same as the number of sides? Ask the students to make another shape, with a different number of sides. Ask each student to count the number of corners and sides in their new shape. Again, is the number of corners larger than, smaller than, or the same as the number of sides? Then ask students, do you think it would be possible to make a shape that has a number of sides that does not match its number of corners? Have them share their ideas as to whether and how that might happen. Then they can try to do it. After they try for a while, ask them to explain the problems they are running into.



Miles of Tiles Post-Activity (Continued)

- ★ What shapes can you make out of other shapes? Each student should have a pile of pattern blocks. Review the triangle and the square. Have students hold up a triangle and a square. Ask students, can you make a larger triangle out of the smaller triangles? Make sure that the triangles are nestled snugly next to each other—no gaps! And make sure none of the tiles overlap! Give students time to work on this. Ask them to count the number of smaller triangles they use to make the larger triangles. Write these numbers down to review later. Then ask students, can you make a larger square out of the smaller squares? Again, no gaps. Give them time to work on this. Ask them to count the number of smaller squares they use to make the larger squares. Write these numbers down, too. Are these numbers different? The same? The students can then try to make a larger triangle using the squares, or a larger square using the triangles. Are both tasks possible?
- ★ Can you match the shape your partner makes? Pair up students at this center. Have each one in the pair put two shapes on a sheet of paper (without showing their partner) and trace around the perimeter of the combined shape. Then students take their shapes off of the paper (again, without revealing what the shapes are to the other student.) Finally, students trade papers with their partners, and try to fit two pattern blocks into the tracing made by their partner. Ask students how they recognize which pattern block to use to fill in a part of the shape they are trying to make. For a greater challenge, the activity can also be conducted with three shapes at a time, instead of two.

Independent Centers:

- ★ Work on the pattern block puzzles on the *Shape Puzzles!* sheets. Students use pattern blocks to fill in the template on the sheet.
- ★ Free play. Encourage students to build flat patterns that do not have any gaps in them. Describe the task to the students before they go to the center. If an adult is available, the adult can take pictures of the creations and later hang them in the room.



Miles of Tiles Post-Activity (Continued)

Extension One: Shape Walk

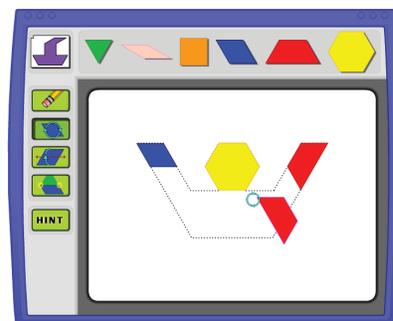
Go on a walk nearby, either inside the school or (if you have permission) around the school block. Ask students to look for shapes. When they see a shape, stop the class. Together, count corners and sides. Ask students: “Is this a shape we know the name for?” Introduce the words for new shapes as they come up. Find a circle. Ask students: “Does this shape have corners? Does it have sides?” Make sure that students understand that a circle has no corners, and consists of just one curve that goes all the way around the circle.

Extension Two: NCTM Patch Tool

If your students enjoyed the *Shape Puzzles!* and they are ready to do something similar on a computer, the National Council of Teachers of Mathematics (NCTM) has a virtual set of shape puzzles along with virtual pattern blocks. You can find this activity on their website:

<http://illuminations.nctm.org/ActivityDetail.aspx?ID=27>

Practice using the tools with your students, showing them how to move, rotate, flip, grid, and erase shapes. Each puzzle also comes with a hint, showing one way to make the shape. There is also a blank template for free exploration.





Shape Puzzles!
Worksheet #1

Can you make the shape below?
Use your pattern blocks.



It's a house!



Shape Puzzles!
Worksheet #2

Can you make the shape below?
Use your pattern blocks.



It's a honeycomb!



Shape Puzzles!
Worksheet #3

Can you make the shape below?
Use your pattern blocks.

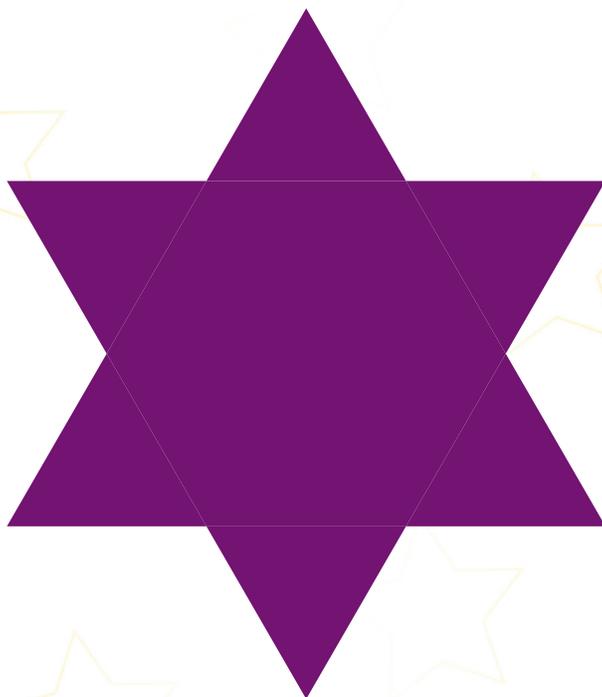


It's a shining sun!



Shape Puzzles!
Worksheet #4

Can you make the shape below?
Use your pattern blocks.

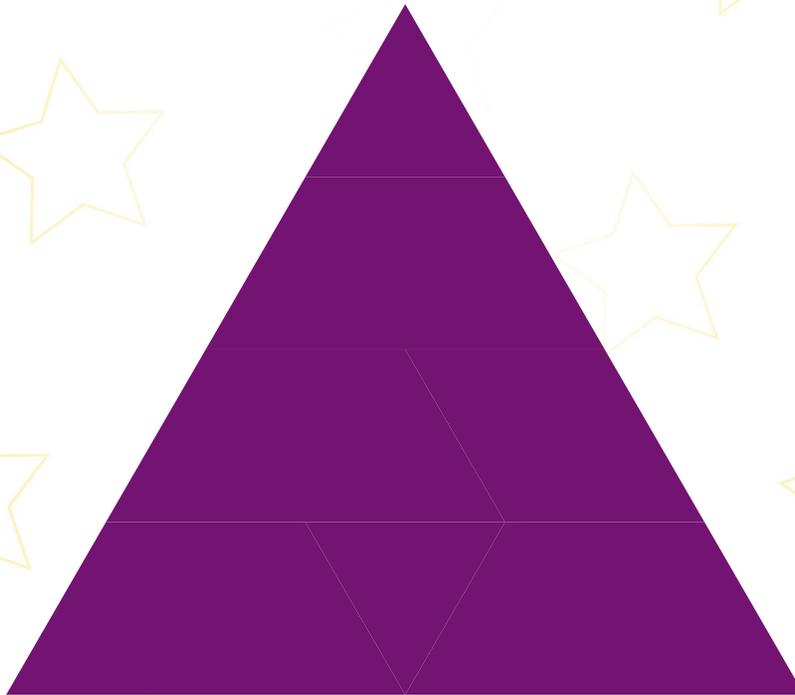


It's a starburst!



Shape Puzzles!
Worksheet #5

Can you make the shape below?
Use your pattern blocks.



It's a big triangle!
Can you use shapes other than triangles to make this triangle?



Shape Puzzles!
Worksheet #6

Can you make the shape below?
Use your pattern blocks.



It's a caterpillar!

Paper Pattern Blocks

Name _____

