Algebra/Geometry Institute Summer 2006

Lesson Plan 2: Symmetry and Tessellations

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Greenville, MS
Grade Level: 6

1 Teaching Objective:

Mississippi Mathematics Framework (Sixth)

2. Explore geometric patterns and relationships.

c. Create tessellations with polygons.

e. Describe, compare, construct, classify, and identify flips, slides, turns (reflections, translations, rotations) as they relate to symmetry.

3. Use and explore concepts of measurement.

c. Use appropriate mathematical tools for determining length, weight, volume, and temperature in the standard (English and metric) systems.

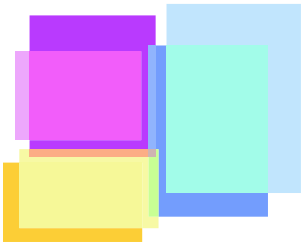
2 Instructional Activities:

The teacher begins the lesson by defining what a tessellations is and its origin. A tessellation is a repeating pattern of distinct shapes that fits tightly together like a puzzle (no holes or overlaps). The word 'tessellation' comes from the Latin word 'tessera' which means a small stone cube. They were used to make 'tessellata' the mosaic pictures forming floors and tilings in Roman buildings. In this three day lesson students will explore special tilings called tessellations. When repeated copies of a shape cover a surface without gaps or overlaps, the result is a pure tessellation. Give examples of tessellations by telling students tessellations may be found in their kitchen or bathroom, which is probably a tessellation of squares. A brick wall is a tessellation of rectangles. The honeycomb of the bee is an example of tessellations with hexagons. You may use the web sites listed below for other examples of tessellations. Allow students to research M.C. Escher and his various tessellations. Encourage students to find information on what influenced him to create his array of tessellations.

- http://www.mcescher.com
- http://www.ozzigami.com.au/
- http://www.cln.org/themes/tessellations.html
- http://gwydir.demon.co.uk/jo/tess/index.htm

Lead students in a discussion of M.C. Escher, who is know as the father of Tessellations. The students will complete the following explorations individually or cooperatively.

Exploration 1



Tessellations of Regular Polygons
Activity 1

In the first activity you will investigate to find which regular polygons will tessellate.

Step 1 Trace a small equilateral triangle pattern on two separate sheets of patty paper.

Step 2 Align one side of the equilateral triangle with one side of the equilateral triangle on the second sheet. Trace the triangle so that the two copies of the triangle are now on one of the patty papers.

Step 3 Continue tracing the triangles in this manner filing the paper with tessellations of equilateral triangles.

What is the measure of each angle of an equilateral triangle?_____ In order for there to be no gaps or overlaps, the measures of all the angles about each point must add up to a complete cycle of 360˚. You have learned that you can also tile a plane with squares. There a four squares at each point in a square tessellation. If each of the four angles measures 90˚, then the sum of the measures of the four angles about each point is exactly 360˚.

Step 4 Repeat steps 1-3 above with a regular pentagon. Is it possible to create a tessellation? Why or why not? What is the measure of each angle of a regular pentagon? How many pentagons can fit around a point? Is there a gap left when you fit the pentagons around a point? What happens when you try to place four pentagons around a point? Record your findings and be ready to discuss.

Step 5 Repeat steps 1-3 with a regular heptagon and octagon if available. Try to fill a sheet of paper with a tessellation of regular heptagons. Can this be done? Why or why not?

Number of sides	3	5	6	7	8
Number of angles					
Measure of each angle					

In conclusion what are the only regular polygons that tile a plane?

Exploration 2

Reflectional Symmetry of Regular Polygons

Activity 2

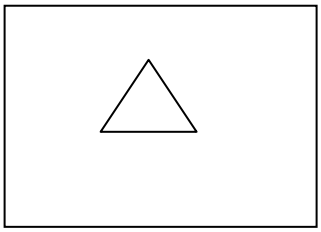
In this first investigation you will look at reflectional symmetry of regular polygons, starting with the equilateral triangle.

Step 1 Trace the equilateral triangle pattern onto patty paper.

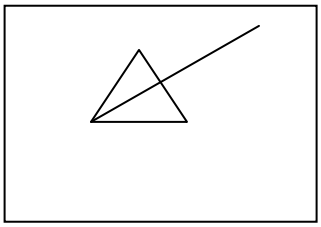
Step 2 Locate a line of symmetry by folding one vertex on top of another so that the fold passes through the third vertex.

Step 3 Copy the triangle and its line of symmetry onto patty paper. Flip the copy over the reflection line. Does the flipped image match with the original shape? How many different lines of symmetry are there?

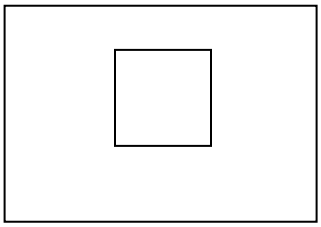
Step 4 Repeat steps 1-3 using a square, regular pentagon, regular hexagon, regular heptagon, and regular octagon. Record your results.



Step 1



Step 3



Number of sides	3	4	5	6	7	8	*n*
Number of reflectional symmetries							

A regular polygon with *n* sides has how many reflectional symmetries? _____

Exploration 3

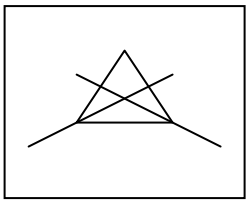
Rotational Symmetry of Regular Polygons
Activity 3

In activity 2 you will view rotational symmetry of regular polygons. Start with an equilateral triangle.

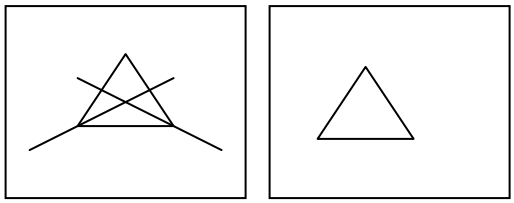
Step 1 Trace an equilateral triangle pattern onto patty paper. Locate the point of rotational symmetry by folding the triangle on two different lines of symmetry. Place a dot where the lines intersect. Place another dot outside the triangle to use as a reference mark.

Step 2 Copy the triangle, the dot, and the reference mark onto another patty paper.

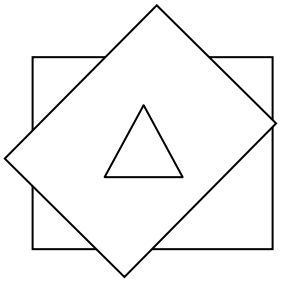
Step 3 Place the copy over the original and hold a pencil tip at the point of rotational Symmetry. Rotate the copy until its image matches with the original triangle



Step 1



Step 2



How many times were you able to make the image coincide with the original using a complete rotation of 360˚? How many times do you need to rotate the copy of the triangle before in matches with the original shape? Record and compare your results.

Number of sides	3	4	5	6	7	8	*n*
Number of rotational symmetries	3						
List of rotational symmetries	120˚ 240˚ 360˚						

A regular polygon with *n* sides has how many rotational symmetries? _____

3. Materials and Resources:

Serra, Michael. *Patty Paper Geometry,* Key Curriculum Press, 1994

Patty Paper
Regular and Irregular polygons
Pencil
Internet ready computer
Construction paper

4 Assessment:

Assess student understanding through small group activities and individual practice activities. After completing the lesson the teacher can redistribute each chart above and allow students to complete the chart individually. Allow students create their own tessellations using at least three polygons. Allow each students to discuss his/her tessellation. Tell why they chose those particular polygons. The teacher may also ask questions such as, was it difficult to arrive at the three shapes, did you have to go through trial and error, or were they able to decide on the shapes easily after doing the explorations.