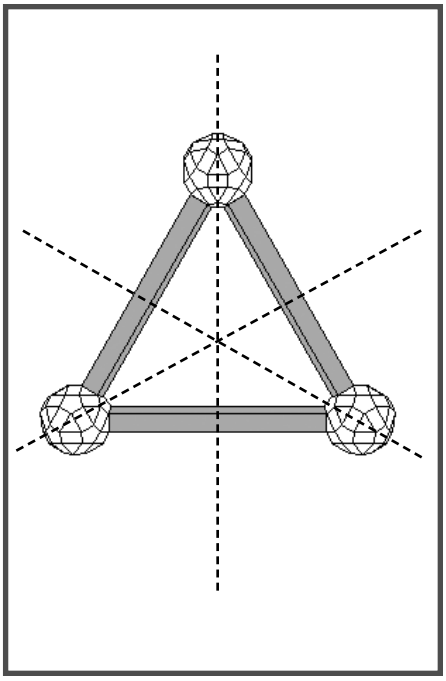
Zome System

Builds Genius!

Multiple Reflection Symmetries

Mathematics
Basic Concept

Lesson Objective:
Students will understand how an object can have more than one line of reflection symmetry. They will find examples of these symmetries in the man-made and natural worlds.



Prerequisite Skills:
Students should be able to name basic polygons ("Geometric Shapes"), and be able to find lines of symmetry in a Zome System model ("What is Reflection Symmetry?").

Time Needed:
One or two class periods of 45 to 60 minutes.

Materials Needed:
- One or two Zome System Creator kits for 25-30 students
- A few natural objects displaying 3-fold symmetry (banana, green pepper, clover, cucumber, flowers with 3, 6, or 9 petals, honeycomb, snow flake, etc.)
- A few natural objects displaying 5-fold symmetry (apple, pear, zucchini, starfish, sand dollar, flowers with 5 or 10 petals, maple leaf, etc.)
- A hand-held mirror

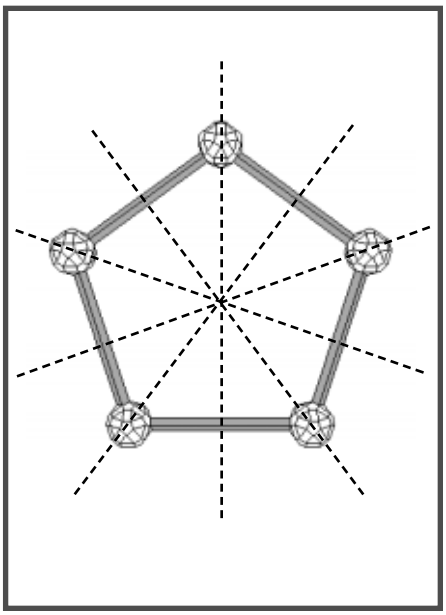
Procedure:
If you work with younger elementary students you may want to cut the fruit and vegetables beforehand. Older students can do their own cutting. The fruit and vegetables should be cut on their equators to reveal their internal symmetry/number of sections. Alternatively you can use one of the many posters or other pictorial depiction of "numbers in nature", that are available from educational publishers.

Multiple Reflection Symmetries

Zome System

Builds Genius!

Divide your class into teams of 3-4 students, and distribute the Zome System elements. Review the concept of reflection symmetry they learned in the class "What is Reflection Symmetry". Tell the teams that they are going to build and find symmetries in the following polygons: a square, a rectangle, an equilateral pentagon, an equilateral triangle, and an equilateral hexagon. The names of the polygons should be written on the board. While they have found one axis of reflection symmetry in the previous class, this time they are going to see if the assigned polygons have more than one axis. *Is it possible to divide a shape in more than one direction and get symmetrical halves?* Discuss this concept as necessary.



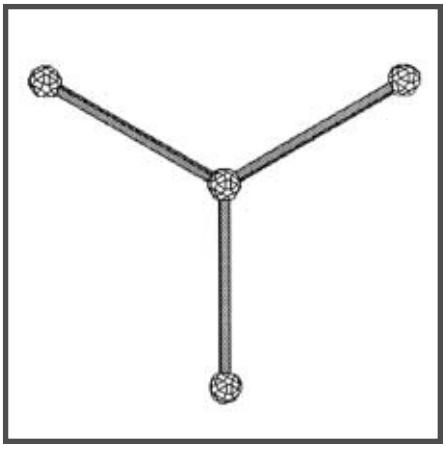
Walk around and help the students while they work. Allow them to use the mirror to check that they really have chosen axes of reflection symmetry. The visible half of the polygon along with its reflection in the mirror will show an image of the entire polygon..

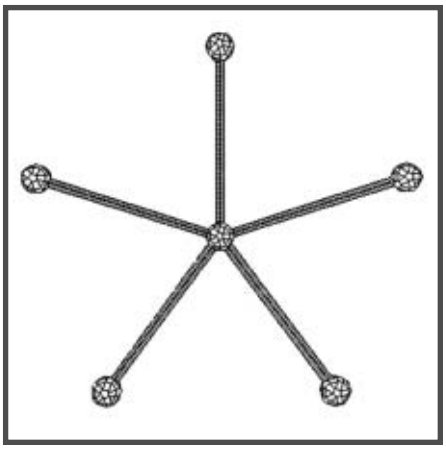
Bring the results from each team together on the board. *How many lines of symmetry have they found in each polygon? Is there a limit on how many lines of symmetry an object can have?* Discuss the results and let students present their findings. Students will realize that the number of symmetry lines is the same as the number of edges in the equilateral polygons. This does not hold true for the rectangle. *Do other objects have reflection symmetry, for instance the letter "H"? What is a good name for each type of symmetry?* Help the group settle on names, the triangle can for instance be said to have 3-fold, 3-directional, or triangular symmetry.

Next turn to the natural objects you have brought in. You can either let the students search for symmetries, or you can display them to the entire class. *How many sections do they have? Why do the number 3 and 5 come back so frequently? How do the 6-fold symmetries of honeycombs, snowflakes, and many flowers relate to 3-fold symmetries* (3X2=6)*? How do the 10-fold symmetries in a pumpkin or an acorn squash relate to 5-fold symmetries (5X2=10)? Which symmetries can they find in the classroom?* Check the students comprehension by letting them show the 3-, and 5-fold

Multiple Reflection Symmetries

symmetries of the natural objects with the help of the two Zome System "stars" in the graphic on the right.





Assessment:
Observe and listen to students as they build their structures. Older students should write about their findings in their math journals.
To meet the standard students must build a correctly show the multiple axes of symmetry in the polygons. To exceed the standard they must verbalize a connections between symmetries in geometry and in natural objects.

Standards Addressed:
* Mathematics standards addressing mathematical connections (NCTM Standard 4).
* Mathematics standards addressing number sense and numeration (NCTM Standard 6).
* Mathematics standards addressing geometry and spatial sense (NCTM Standard 9).

Transfer Possibilities:
Follow up this class with a "math hike" in a local park or nature area to search for additional manifestations of numbers in nature. This exploration serves as an introduction to Fibonacci sequences ("Fun Fibonacci") and other mathematical patterns relevant in biology and geology. Continued work on various types of symmetry ("Rotational Symmetry," "Translation Symmetries and Tilings," "Tilings with Multiple Symmetries," and "Spiral Symmetries"). Discussions on the use of geometry and symmetry in art and design.