Zome System

Builds Genius!

2-D and 3-D Stars

Mathematics
Intermediate Concept

Lesson Objective:
Students will examine how the process called stellation can generate star shapes in two and three dimensions. They will also explore the concept of geometric progression.

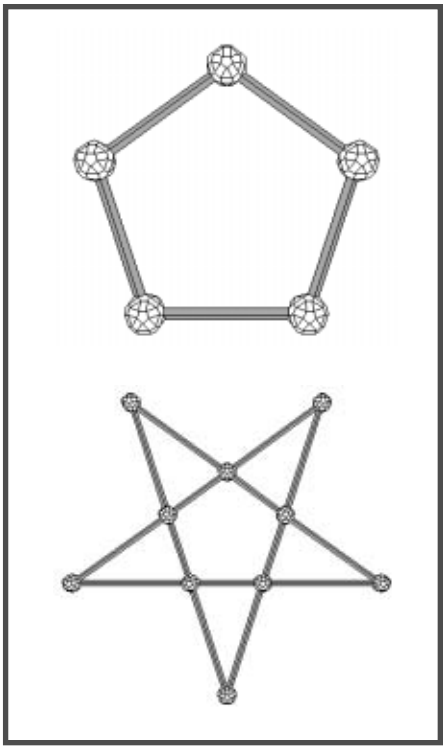
Prerequisite Skills:
Knowledge of geometry nomenclature ("Naming 2-D and 3-D Shapes"). Ability to identify and build the icosahedron and the dodecahedron ("Plato's Solids - I", and "Plato's Solids - II").

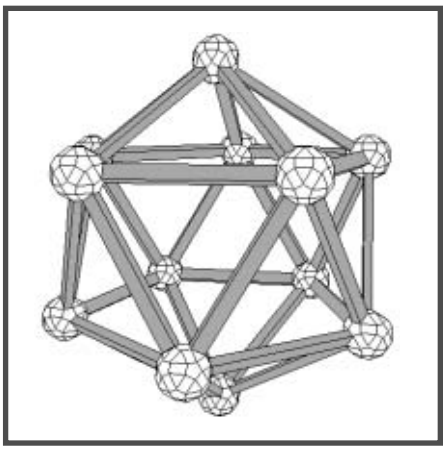
Time Needed:
Two class periods of 45-60 minutes.

Materials Needed:
• Two Zome System Creator Kits for 25 - 30 students

Procedure:
Inform the class that they are going to explore an interesting process of changing geometrical shapes. Divide the class into teams of 3-4 students. The first challenge for the teams is to build an equilateral pentagon, and then extend the edges of the pentagon until these edges intersect with each other. *What does the resulting figure look like? How many arms does the shape have? Is it symmetrical?*

The process of extending the edges of a polygon or a polyhedron is called stellation. The resulting figure is this case is called an edge stellated pentagon or a pentagram. No one knows who first discovered this figure. We do know that the Greek mathematician and philosopher Pythagoras knew about it. His Pythagorean brotherhood used it as their secret symbol, known only to members. In fact, they drowned a fellow member for revealing it to a non-member.





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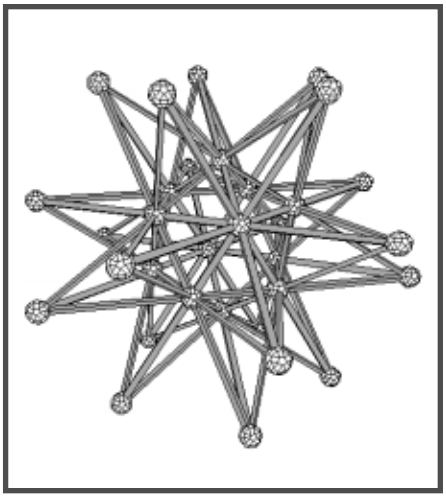

What shape would we have if we connected the outer five points? Give the teams time to complete the figure. *Which color strut did they have to use? Which length? Can the figure be stellated again? What do the outer points form? Are the pentagons increasing in size by the same amount every time? How long can this process continue?* Increasing a shape the same way every time is called a geometric progression or a fractal progression.

Can we stellate in this manner in three dimensions as well? Ask the students to build an icosahedron out of the shortest blue struts. Once the icosahedron is complete they should stellate it. Circulate and assist as needed as the teams find their own solutions to this challenge. *Which edges should they be extending? Which struts will they need?* The stellation will yield a star polyhedron. *Based on the process of naming the 2-D star, what is a good name for the new 3-D shape* (edge-stellated icosahedron)*? What kinds of shapes make up the points of the star* (triangular pyramids)*? How many such pyramids does the shape have* (twenty)*? What shape is defined by the outer points* (dodecahedron)*? Can this resulting polyhedron be stellated in turn? What is the name of the resulting star polyhedron* (edge-stellated dodecahedron)*? What shape are the points* (pentagonal pyramids)*? How many such pyramids does the shape have* (twelve)*? What shape is defined by the outer points now* (icosahedron)*?. Does this sound familiar? Can we continue this to make it larger? How about smaller? What kind of progression is this geometric or fractal?*

The students should complete the lesson by writing a definition of stellation in their math journal. The should also attempt to describe the duality of the icosahedron and the dodecahedron.

Assessment:

Observe and students as they build their structures, and take notes of their presentations. Review definitions in math journals. To meet the standard, students must build the 2-D and 3-D stellations. To exceed the standard, their definitions must convey the geometric progression of the stellations.

Standards Addressed:

* Mathematics standards addressing mathematics as a means of communications (NCTM Standard 2).
* Mathematics standards addressing the study of the geometry of one, two, and three dimensions in a variety of situations (NCTM Standard 12).

Transfer Possibilities:

Other transformations of geometrical shapes (“Archimedian Solids”). Also explorations of geometric growth patterns in the natural world (“Multiple Reflection Symmetry” and “Fun Fibonacci”).