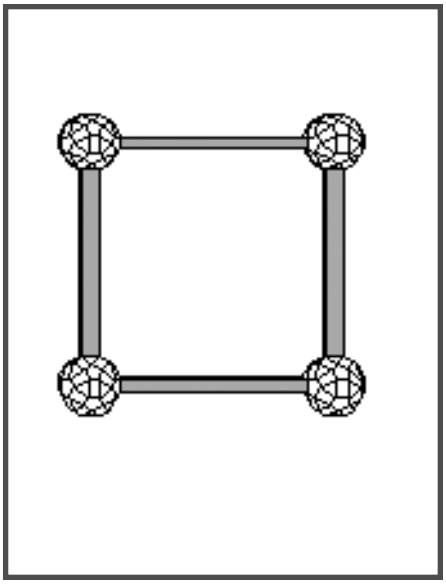
Cubes - I

Mathematics
Basic Concept

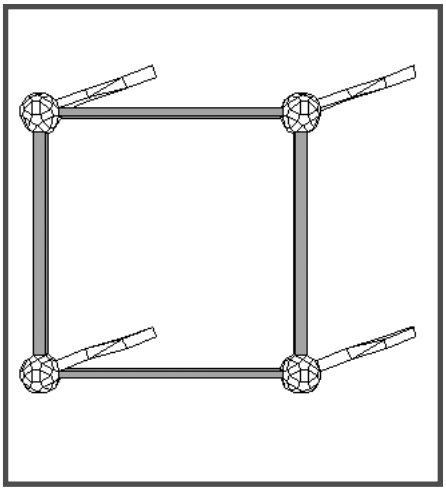


Lesson Objective:
Students will learn basic properties of the cube, including parallel and perpendicular lines, number patterns, and symmetry groups associated with the cube.

Prerequisite skills:
Familiarity relating geometric shapes and symmetry lines to representative numbers ("Shape and Number," "3-D Triangles" and "Speed Lines!").

Time Needed:
One class period of 45-60 minutes.

Materials Needed:
- One or two Zome System Creator Kits for class of up to 24 students
- Overhead projector



Procedure:
Divide your class into teams of 3-4 students and distribute Zome System components evenly among the teams. Based on their experiences in the "Shape and Number," "3-D Triangles" and "Speed Lines!" explorations, challenge each team to build a "3-D number 4." Students may ask what you mean by a "3-D number 4." Rather than leading a group discussion at this point, suggest that the teams discuss the concept as they build.

Allow 10-15 minutes for this exploration, during which time you can offer guidance on an individual or team basis. *What was the shape of a 2-dimensional number 2? A 2-D number 3? A 2-D number 5? Why did you decide a rectangle is a 2-D number 2? A triangle is a 2-D number 3? A pentagon is a 2-D number 5? What color struts do you think should be used to build a 2-D number 4? A 3-D number 4? Why?*

What was the shape a 3-D number 3 (i.e., a 3-D triangle?) What shapes did you use to build the 3-D triangle? If you know the shape of a 2-D number 4, do you know which shape(s) build a 3-D number 4?

If the students are having problems they can use a step-by-step procedure and start by building a "2-dimensional number 4" based on their answer to the previous questions. *How can you be sure that the square is a 2-D number 4?* To "break into" the 3rd dimension, they can then add "speed lines" to the 2-D number 4. *Which direction should the speed lines go? What color struts should be used?* To complete the jump to "3-space," put nodes on the ends of the speed lines and connect the new nodes with struts.

At the end of the exploration, ask for a representative of each team to present their team's "3-D number 4s" to the class and explain why it answers the challenge. Team representatives can use the overhead projector to show a 2-D shadow of their 3-D models.

After the presentation, discuss the various concepts comprising the idea of a 3-D number 4. *How do you know it is a 3-D number 4? How many nodes does it take to make a 2-D number 4? How many struts? How many 2-D number 4s does it take to make a 3-D number 4? How many nodes? How many struts?* Students should record their observations in their math journals. They can include a table of the number relationships they discover, as shown below.

What is another name for a 3-D number 4? (Cube, hexahedron) *If we were to describe this 3-D shape, how would we?* (A regular hexahedron has six faces which are all regular polygons. A regular polygon is a convex 2-D shape which is made up of same length lines all meeting at the same angle. For example, a 2-D number 4 is commonly called a square. It consists of a loop of 4 lines of equal length, joined at 4 points at equal (right) angles. A regular polyhedron is a 3-dimensional shape formed from regular polygons which also has equal angles between faces.)

Students should save their cube models for the "Cubes - II" exploration.

As an extension the class can discuss what a 4-dimensional cube would look like? *Is there any way to predict what factors determine the structure of a 4D cube based on the number chart below?*

	Number of points	Number of lines	Number of 2-D squares	Number of 3-D squares
0-D # 4				
1-D # 4				
2-D # 4				
3-D # 4				
4-D # 4				

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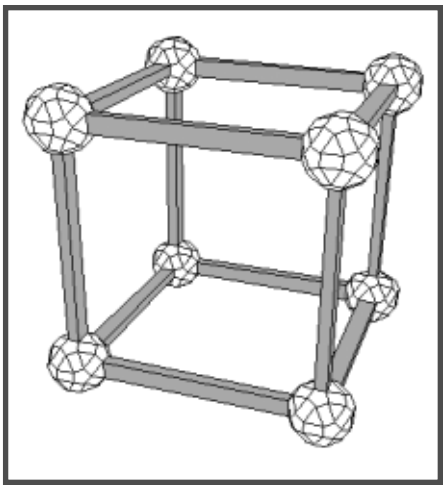
Assessment:
Take notes during the discussions and review written work in math journals. To meet the standard, students should understand the basic properties of the cube, including parallel and perpendicular lines, number patterns, and symmetry groups associated with the cube. To exceed the standard, students will be able to extrapolate to four-dimensional figures.



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

Transfer Possibilities:
Continued work on perspectives of the cube and perspective drawing ("Cubes - II, III, and IV" lesson plans.)