Zome System

Builds Genius!

Tilings with Multiple Symmetries

Mathematics
Intermediate Concept

Lesson Objective:
Students will understand how some tilings can display rotational and/or reflection symmetry in addition to translational symmetry. They will learn how to demonstrate how these tilings can be generated using either one of the symmetry concepts.

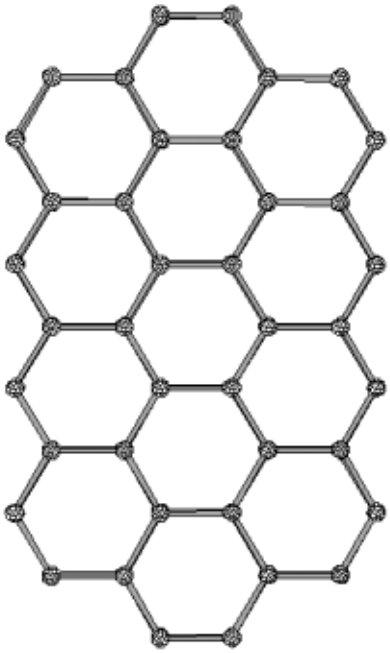
Prerequisite Skills:
Ability to differentiate between different types of symmetry ("What is Reflection Symmetry," "Multiple Reflection Symmetry," "Rotational Symmetry," "Plane Patterns," "Triangle Tiles - I," and "Triangle Tiles - II").

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

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

Procedure:
Start the class with a brief review of how tilings work. Students should restate their definitions of translation, rotation, and reflection symmetry. The following unit will cover tilings that display more than one type of symmetry, in addition to translational symmetry.

Divide the class into teams of 3-5 students, and distribute the Zome System pieces evenly. Each team is to build a polygon, and discover how to tile with it. Allow 15 to 20 minutes for this exploration. When the tiling are completed, students should study them and discuss their findings. *Does it have any symmetries? More than one? More than two? Which ones? What is the symmetry number (for example, 2-fold, 3-fold, and upwards) for each type of symmetry in their designs?* All findings should be recorded by the



1. translation in multiple directions
2. 2-fold reflection along edges
3. 3-fold reflection on each point
4. 180° rotations around every edge midpoint
5. 120° rotations around each point

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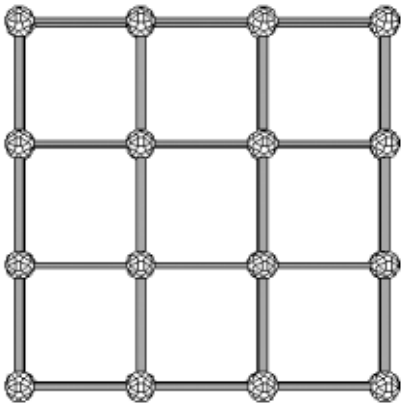
students in their math journals.

The teams should introduce their tiling to the rest of the class. The presentation should include a sample of the tile used in the tiling, and which symmetries are inherent in the tiling. The team should demonstrate how the various forms of symmetry can be used to repeat the tile across the plane. *Have all the symmetries been found? Are their any others in the design?*

See graphics for sample symmetry analyses in tilings.

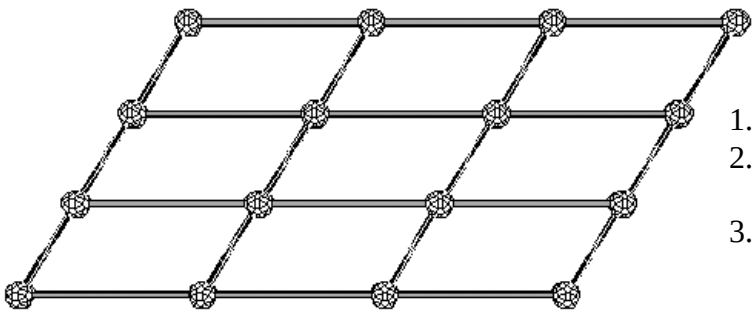


1. translation in multiple directions
2. 180° rotations around edge mid-points (2-fold rotation)
3. 90° rotations around each point (4-fold rotation)
4. 4-fold reflection at points
5. 2-fold reflection at edge midpoints

Assessment:
Discuss the definitions offered by the students individually and with the class, and review their math journals. To meet the standard, students must build a tiling with multiple symmetries, and be able to present these symmetries to the class. To exceed the standard they must verbalize definitions for the various symmetries.

Standards Addressed:
* Mathematics standards addressing the study of the geometry of one, two, and three dimensions in a variety of situations (NCTM Standard 12).

Transfer Possibilities:
Further explorations of symmetry and tilings in 2 and 3 dimensions ("Non-Periodic Tilings - I: Kepler's Tilings," "Non-Periodic Tilings - II: Richert-Penrose Tilings," "Spiral Symmetries," and "3-D Triangle Tiles").



1. 2-fold reflection each diagonal
2. 2-fold rotation at each vertex point
3. translation in multiple directions