Lesson 5: **Investigating Nets and Polyhedra**

Lesson Topic

3-D shapes and their nets

Grade

5

Lesson Length

50 minutes

NCTM Standards Addressed

- Make and test conjectures about geometric properties and relationships and develop logical arguments to justify conclusions
- Build and draw geometric objects
- Create and describe mental images of objects, patterns, and paths
- Identify and build a three-dimensional object from two-dimensional representations of that object
- Identify and draw a two-dimensional representation of a three-dimensional object

PA Standards Addressed

- Describe in words how geometric shapes are constructed.
- Construct two- and three-dimensional shapes and figures using manipulatives, geoboards and computer software.

Student Objectives

Students will:

- create a net for a given polyhedron;
- determine the corresponding polyhedron for a given net.

Grouping for Instruction

- Whole class for launch and closure
- Small groups of 4 or 5 for the investigation

Overview of Lesson

Students will investigate several polyhedra (cube, tetrahedron, and one of their choosing) and their corresponding nets. Given a polyhedron they must find at least one net. Given a net they must visualize the solid the net will produce.

Background Information

Students need to be familiar with putting together and taking apart Polydrons™ and the concepts of square, triangle, pentagon, hexagon, and congruence.

Materials and Equipment

- classroom set of Polydrons™
- masking tape for each team
- 500 1-inch squares
- overhead projector

Lesson 5 Procedure

A. Motivation and introduction

1. Define the term *polyhedron* as a closed 3-dimensional surface formed by polygons. Consider objects in your own home and write down a list of polyhedra (the plural of polyhedron). Show students examples of polyhedra. (Wait.)
2. Show the students a cube made from Polydrons™ and say: "For example, a cube is a polyhedron with each face being a square. Notice that the surface of squares divides space into three regions—the region inside the surface, the surface itself, and the region outside the surface."
3. Say: "Look around you. Do you see any polyhedra in this room?" Ask students to explain why they think an object qualifies as a polyhedron. Allow other students to question whether an object is a polyhedron.
1. Say: "Consider objects in your home. What are some polyhedra in your home?" List several on the overhead projector.
2. Help students find one net of the cube. Show them how you can create a "T" with the Polydrons™ used to create a cube. Say: "This is one net of the cube. It consists of faces of the Polydron™ where each face is connected to at least one other face along one entire side. Do you think there are any other nets of the cube?"
3. Say: "Let's investigate nets of some polyhedra"

B. Development (including discussion points and feedback)

1. Place the students in heterogeneous cooperative groups of about four students each.
2. Assign a task to each person in a team. (Leader, presenter, recorder, materials person)
3. Ask the teams to complete the worksheet "Investigating Nets and Polyhedra."
4. Circulate among the groups, guiding them to complete the project and observing students' participation, interactions, and understanding.
5. Ask each group to report on one net they found for the cube or another polyhedron.

6. Make sure each student understands the concept of a net. Ask questions such as "What makes this a net?" and "Why is this disconnected set of squares not a net?" and "Could you have a net of the cube that contained only five squares? Explain your reasoning."
7. Fold a cloth net around a pyramid with a square base made with Polydrons™ to emphasize the relationship between a figure and its net.

C. Summary and closure

1. Ask group to work together to write three statements about what they did today and why it is important.
2. Have groups share one statement, and continue going around the room from group to group until all points are made.
3. Summarize by emphasizing:
   - the definition of a net
   - that there are a number of different nets for a given polyhedron
   - that nets of different polyhedra are different.

D. Assignment

Give each student a net for a prism on a sheet of paper. Have them cut out the net and create the corresponding prism. Invite them to decorate their prism.

Assessment

- Observe the students during the group project.
- Record how they are working in their group and whether the students can visualize a net from the solid and the solid from a net.
- Grade the group project and the presentations (if they are more formal than implied in the project),
- Grade the homework.

Extensions

1. A cube is an example of a **prism**—a polyhedron formed by congruent polygons for the base and top and parallelograms for each side face. Use the Polydrons™ to create three other prisms.

2. The tetrahedron is an example of a **pyramid**—a polyhedron formed with a polygon for the base and sides formed of triangles that meet at a single point (called the **apex**) off the plane containing the base. Use the Polydrons™ to create three other pyramids.

3. The cube has six faces, eight corners (called **vertices**), and twelve edges. The mathematician Leonhard Euler (pronounced "oiler") discovered a relationship between

the faces, vertices and edges of any polyhedron. Use the Polydrons™ to create other polyhedra. Create a table showing the number of faces, vertices, and edges for each polyhedron. Look for a pattern in the table. Create a formula that relates the faces, vertices, and edges.

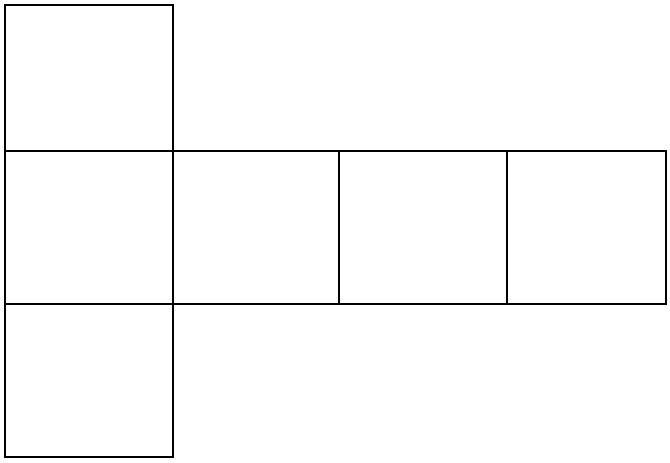
4. A **Platonic solid** is a polyhedron in which each face is a regular polygon, the faces are all congruent, and each vertex has the same number of polygons meeting at the vertex. There are five Platonic solids. Find them. Create a net for each Platonic solid.

5. Use the internet to find information on the **Archimedean solids**. Find a net for each of the Archimedean solids. How do the Archimedean solids differ from the Platonic solids?

6. Research kaleidocycles. Use an M. C. Escher tessellation to create a kaleidocycle. Describe the polyhedron used and any transformations Escher used in creating the tessellation.

Worksheet: **Investigating Nets and Polyhedra**

Each team has been given a cube made using Polydrons™. If you take apart the cube while keeping each square attached to the entire side of at least one other square and then lay the resulting figure flat, you will have a **net** for the cube consisting of the six square faces of the cube. Below is one example of a net for the cube.



Find as many nets as you can that can be used to create a cube. If you are not sure if a particular net can be used to create a cube, make the net using the cardboard squares and masking tape and then try to fold the net into a cube. Sketch all the nets of the cube your team found on the grid paper provided.

Show a net of six squares that cannot be used to create a cube.

A regular tetrahedron is a polyhedron formed by four equilateral triangles. Create a regular tetrahedron using the Polydrons™.

Find a net for the regular tetrahedron. Sketch the net in the space below.

Create a net that can be used to create a polyhedron. Sketch the net in the space below. Trade nets with another team. Can you predict what the resulting polyhedron will look like? Describe or sketch the polyhedron you predict will result next to the net. Test your prediction by using the Polydrons™ to create the polyhedron. Were you correct?