

NTTI Media-Rich Lesson

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NAME

Poly-Mania

LESSON TITLE

Grades 9 - 10

GRADE LEVELS

1 class period (90 minutes)

TIME ALLOTMENT

OVERVIEW

In this lesson, the students will explore connections between two-dimensional polygons and three-dimensional polyhedrons and apply them to real life situations.

SUBJECT MATTER

Geometry

LEARNING OBJECTIVES

The student will be able to:

- Identify and classify polyhedra.
- Identify and construct the Platonic Solids
- Find a pattern in the number of faces, edges, and vertices of polyhedrons.
- Construct models of polyhedrons

STANDARDS

Georgia Quality Core Curriculum Standards (<http://www.glc.k12.ga.us>)

Euclidean Geometry Standards for grades 9-12

Topic: Problem Solving, Visualizing, Reasoning

Standard 3:



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Students will be able to use visualization skills to explore and interpret both two- and three-dimensional geometric figures using such topics as projections, cross sections, and locus problems.

Topic: Perimeter, Area, and Volume

Standard 35:

Students will be able to identify polyhedrons, including prisms, pyramids, cubes, and tetrahedrons; cylinders; cones; spheres; faces; edges; vertices; bases; and lateral edges.

National Council for Teachers of Mathematics Standards

Geometry Standards for Grades 9-12

Students will be able to analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.

Students will be able to use visualization, spatial reasoning, and geometric modeling to solve problems.

Communications Standards for Grades 9-12

Students will be able to organize and consolidate their mathematical thinking through communication.

Students will be able to communicate their mathematical thinking coherently and clearly to peers, teachers, and others.

Students will be able to analyze and evaluate the mathematical thinking and strategies of others.

Students will be able to use the language of mathematics to express mathematical ideas precisely.

Representation Standards for Grades 9-12

Students will be able to create and use representations to organize, record, and communicate mathematical ideas.

MEDIA COMPONENTS



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Videos

Relationships Between 2D & 3D, *Geometry Journey Series*

This video is designed to show the relationship among 2D figures and 3D shapes to help students better visualize the three-dimensions.

Websites

3Quarks – GIF Animations – Platonic Solids

<http://www.3quarks.com/GIF-Animations/PlatonicSolids/>

This website allows you to download GIF Animations of Platonic solids for use in PowerPoints or web pages.

Poly

<http://www.peda.com/poly/>

This website allows the user to download the Poly 1.09 program. Poly is a shareware program for exploring and constructing polyhedra. With Poly, you can manipulate polyhedral solids on the computer in a variety of ways. Nets of polyhedra may be printed and then cut out, folded, and taped, to produce three-dimensional models.

MATERIALS

Per Class:

- Popsicle Sticks (the same amount as students in your class)
- 16 oz. Plastic Cup
- TV/VCR
- Gateway Computer or LCD Projector/desktop or laptop computer for teacher use
- Videotape
- Overhead Projector (optional)
- Computers for student use

Per student:

- Handout # 2: Relationships Between 2D & 3D
- Handout #4: Building Polyhedrons Group Activity
- Handout #5: Faces, Edges, & Vertices Group Activity

Per Group of Students:

- An envelope with polygon names
- An envelope with properties of polygons
- 100 bendable straws (multicolored if possible)
- Pair of scissors,



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- 3 pieces of kite string about 2 feet long
- 1 role of clear or transparent tape
- One-hole hole puncher
- 2 sheet of construction paper
- Colored markers

PREP FOR TEACHERS

Prior to the teaching of this lesson the teacher should do the following:

- Prepare the polygon envelopes (polygon names & properties). Use Handout #1: Polygon Match Game.
- Prepare Platonic Solids on PowerPoint or overhead. Go to the following website and download Platonic Solids Gif images (the site gives you permission to download images): <http://www.3quarks.com/GIF-Animations/PlatonicSolids/>
- Watch the video ***Relationships Between 2D & 3D***
- Cue the videotape to the main menu screen that has an arrow pointing towards *2D Shapes to Polyhedrons*.
- Prepare polyhedron lists. These lists will be place in a bag and each group will choose one. Use Handout # 3 - Polyhedron Assignment Cards.
- Bookmark the website used in the lesson on each computer in your classroom.
- Download the Poly shareware program onto each computer.
Go to: <http://www.peda.com/poly/>.

INTRODUCTORY ACTIVITY: SETTING THE STAGE (Engage)

Divide the class into groups of 3 or 4 students. Assign each group a number and each child a letter. Let the students know that they will be called upon to answer questions by calling out their group number followed by the letter they were assigned in the group. Since you have 3 or 4 students per group, you will use the letters a-d. The teacher will use popsicle sticks with the group numbers and letters written on them to randomly select a student to call on. The popsicle sticks will be placed in a cup, and the teacher will pull a stick out of the cup to call on students.

Give each group a set of two envelopes. One envelope will contain polygon names and the other will contain properties of polygons. Announce to the students that they will be playing Polygon Match Game. The students will match the properties with each polygon name. Let the students know they must choose the property that best identifies the polygon. Let the students work on this activity for 10 minutes. At the end of ten minutes the teacher will hold up various polygons and ask the students to name the properties. You will call on the students as established at the beginning of the activity.

LEARNING ACTIVITIES

Interactive Techniques



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Step 1:

The teacher will say, “Today we will show a connection between polygons and polyhedron. Let’s recall that a polygon is a closed figure in a plane formed by connecting line segments. These figures are considered two-dimensional or 2D since they are on the plane. When we take these several polygons and connect them in a single region of space to form a solid the figure will become three dimensional or 3D. We call this 3D figure a polyhedron. When we talk about more than one polyhedrons we use the plural form polyhedrons or polyhedra.”

Step 2:

Pass out a handout listing the names of various polyhedra.

Provide students with a FOCUS FOR MEDIA INTERACTION by saying, “I will now show you a series of video clips. Your task is to answer the questions on the handout that you were given based on what you see on the video clips.”

Cue the videotape to the main menu screen that has an arrow pointing towards *2D Shapes to Polyhedrons* and PLAY. PAUSE the video at the point that the prism begins to fill up. FAST FORWARD to the next menu. The arrow should be pointing towards *Rectangular Solid & Cube*. PAUSE the video at the point that the rectangular solid begins to fill up. FAST FORWARD to the next menu. The arrow should be pointing towards *Pyramid*. STOP the video at the point that the square pyramid begins to fill up. Discuss what the students put on their handouts for about five (5) minutes.

Step 3:

Teacher says, “As we have just seen on the video, the flat surfaces of polyhedrons are called faces. A segment where two faces intersect is called an edge. The point of intersection of three or more edges is the vertex of the polyhedron. “

“Just as a polygon is classified by its number of sides, a polyhedron is classified by its number of faces. The prefixes for polyhedrons are the same as those for polygons with one exception. A polyhedron with four sides is called a tetrahedron.”

“If each face of a polyhedron is a congruent regular polygon, we call that polyhedron a regular polyhedron. There are five regular polygons called **Platonic solids**. These polyhedra were named after the mathematician and philosopher Plato.”

At this point refer to the PowerPoint or overhead to show each solid individually. Prepare Platonic Solids on PowerPoint or overhead. (The teacher may want to go to <http://www.3quarks.com/GIF-Animations/PlatonicSolids/> to download the Platonic Solids Gif images. The site gives you permission to download images.)

Step 4.

Discuss with the students the number of faces, edges, and vertices of each Platonic solid.



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Tell the students, “A polyhedron can be shown in two-dimensions by using a *net*. A net is a pattern that can be folded to form a polyhedron.”

At this point display on PowerPoint or overhead of the nets of the Platonic solids.

At this point discuss prisms and pyramids. Explain to students that prisms and pyramids are classified by their bases.

CULMINATING ACTIVITY

Now that we have an understanding of polyhedron, let us build some of them. Each group will pick from the bag their assigned polygons to construct, as well as the ones that you will research via the internet.

Step 1:

Have one person in your group go to the supply station and gather the materials.

Step 2:

Using the Platonic Solids Nets handout, build your assigned polyhedra.

Step 3:

Using the construction paper, label your polyhedrons.

Step 4:

Punch a hole in the construction paper and tie it to the polyhedron with a piece of the kite string.

Step 5:

Use the remainder of the kite string to attach to the top of the polyhedrons so that they can be hung in the classroom.

Step 6:

Assign a person to go on the internet to print pictures and nets of the various assigned polyhedrons. FOCUS FOR MEDIA INTERACTION: Using the Poly 1.09 program on the computers, each group will be find the assigned polyhedrons, print out a picture of the polyhedrons and its net.

Step 7:

Fill out the “Faces (F), Edges (E) and Vertices (V)” handout. The student is to look for a relationship among the vertices, faces, and edges of the polyhedra. The students are to fill out the chart using their assigned polyhedra.



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Step 8:

Have students look for patterns in the table by adding, subtracting, or multiplying V , F , and E . By doing this, the students can discover a formula that is commonly known as Euler's Formula for Polyhedrons.

Step 9.

Attach all assignments together. Place the names of all group members each sheet. Let the students know that during the next class session, they will report to the class.

CROSS-CURRICULAR EXTENSIONS

Science

- Show how polyhedrons play a role in the structure of molecular atoms.
- Show the relationship between the Platonic Solids and the elements.

English and Social Studies

- Research and write a paper on the Philosophies of Plato.

Art

- Show how paintings and pictures incorporate polyhedrons.
- Using origami, build different polyhedrons.
- Create pictures using polygons and polyhedrons.

COMMUNITY CONNECTIONS

- Bring in an artist to demonstrate and display artwork that he or she has done using polygons and polyhedrons.
- Bring in a jeweler to show gemstones of various polyhedral shapes.



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Handout #1: Polygon Match Game

Below are the polygon names and properties that are to be used in the Polygon match game. Make as many copies as necessary. You will net one set per group of 3 or 4 students. You will also need two (2) envelopes per group. Place the polygon names in one envelope and the properties in the other.

Polygon names:

Pentagon	Heptagon	Kite
Triangle	Equilateral Polygon	Square

Rhombus	Quadrilateral	Convex Polygon
Decagon	Trapezoid	Parallelogram

Handout #1: Polygon Properties (continued):

A five-sided polygon.
A Polygon whose sides are equal in measure.
A polygon in which no segment connecting two vertices is outside the polygon.
A ten-sided polygon.
A seven-sided polygon.

A polygon with three sides.
A polygon with four sides.
A four-sided polygon in which both pairs of opposite sides are parallel.
A four-sided polygon with exactly two pairs of distinct congruent consecutive sides.
An equilateral four-sided polygon in which both pairs of opposite sides are parallel.
A four-sided polygon with exactly one pair of parallel sides.
An equiangular and equilateral four-sided polygon in which both pairs of opposite sides are parallel.

Handout # 1: Polygon Match Game Answer Key

Pentagon: A five-sided polygon.

Equilateral polygon: A Polygon whose sides are equal in measure.

Convex Polygon: A polygon in which no segment connecting two vertices is outside the polygon.

Decagon: A ten-sided polygon.

Heptagon: A seven-sided polygon.



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Triangle: A polygon with three sides.

Quadrilateral: A polygon with four sides.

Parallelogram: A four-sided polygon in which both pairs of opposite sides are parallel.

Kite: A four-sided polygon with exactly two pairs of distinct congruent consecutive sides.

Rhombus: An equilateral four-sided polygon in which both pairs of opposite sides are parallel.

Trapezoid: A four-sided polygon with exactly one pair of parallel sides.

Square: An equiangular and equilateral four-sided polygon in which both pairs of opposite sides are parallel.



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Handout # 2: Relationships Between 2D & 3D

As you watch the video clips, answer the following questions.

1. What is a polyhedron?
2. Where do pairs of faces of a polygon meet?
3. How many edges meet at a vertex?
4. What is a prism?
5. What is another name for a cube?
6. How many sides does a cube have?
7. What is a pyramid?
8. Name some types of pyramids.



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Handout #5: Faces, Edges, & Vertices Group Activity

Complete the Chart using the polyhedrons that you were assigned.

Polyhedron Name	# of Faces (F)	# of Edges (E)	# of Vertices (V)
1.			
2.			
3.			
4.			
5.			