

Discovering Math: Geometry

Teacher's Guide



Grade Level: 3–5

Curriculum Focus: Mathematics

Lesson Duration: Four class periods

Program Description

Discovering Math: Geometry – From symmetry and three-dimensionality to congruent shapes and the use of scale, introduce elementary students to more advanced properties and concepts of geometry.

Lesson Plan

Student Objectives

- Use basic geometric language to describe and name shapes.
- Identify basic properties of figures.
- Combine two- and three-dimensional figures to create new figures and describe the new figure by the parts of the whole.
- Identify and create similar and congruent shapes.
- Use transformations to create movement of an object.
- Identify and create lines and angles within a map.

Materials

- *Discovering Math: Geometry* video
- Geoboards
- Rubber bands
- Shape Chart (see below)
- Geometric Shape Cards (see below) to be cut before class
- Models of three-dimensional shapes
- Modeling clay
- Dot paper
- Tangrams or pattern blocks
- Graph paper
- Toothpicks

- Simple map
- Various maps

Procedures

1. Ask students to name the two-dimensional geometric shapes they saw in the video. They should list the following: square, triangle, rectangle, pentagon, octagon, rhombus, parallelogram, and trapezoid. Discuss how geometric shapes have many properties like number of sides, number of angles, length, and width. Tell students they will be working with a partner to further explore and create two-dimensional geometric figures.
 - Assign each student a partner. Give each pair one geoboard, rubber bands, and a set of Geometric Shape Cards. Give each student a Shape Chart. Have students take turns asking each other to create shapes from the cards on the geoboard. The student with the cards should check their partner's work on the geoboard to be sure the correct shape was made. Have them discuss the properties of each shape and record their observations in the Shape Chart. They can repeat shapes to understand that shapes can have the same properties but different sizes (similar shapes).
 - Extension: Students can research other shapes like hexagons, decagons, etc. to create on the geoboard and add to their chart.
 - Discuss the shapes created and have students share the properties they identified for each. Create a class chart to display as a reminder of the different geometric shapes and their properties.
2. Display models of three-dimensional shapes. Ask students to identify the shapes and their properties. Remind them of the properties that were shown in the video (length, height, width, depth, and number of faces, edges, and corners). Tell students they will work with modeling clay to create their own three-dimensional shapes. They will also combine shapes to form objects and describe the objects' properties.
 - Provide each student with modeling clay. Ask students to think about a structure they could create by combining or subdividing three-dimensional geometric shapes. If time allows, have them draw a picture of the shape they are thinking of creating.
 - Have students mold the clay into the three-dimensional shapes and then combine or subdivide the shapes into a new object. They should describe their objects in writing by listing the shapes that make up the object and the number of faces, sides, and angles on each shape. Ask them to mention if the object has bilateral symmetry.
 - Discuss real-world examples of buildings or structures that are composed of three-dimensional shapes. Emphasize the use and importance of geometric shapes in architecture.
3. Display two congruent squares and two similar squares. Display the words similar and congruent. Discuss the meanings of the words and identify the square as either similar or congruent.

Similar figures have the same shape and proportions but have different sizes.

Congruent figures have the same shape and size (all sides and angles are equal).

Tell students they will work with a partner to practice making similar and congruent figures.

- Assign each student a partner. Give each pair two geoboards, rubber bands, and dot paper. Explain that one student will create a shape on their geoboard. Then the second student will create a similar shape and a congruent shape on their board. They should copy their figures onto dot paper. Model examples with the class before allowing the pairs to work independently. Students should see that similar shapes have the same shape and proportions but are different sizes and congruent shapes have exactly the same size, shape, and angles.
 - Have students share some examples with the class. Ask them to share a set of shapes they think is unique. Challenge them to create objects that have many sides and angles.
4. Ask students how the artists in the video used transformations to create movement and have them share and explain their thoughts. The artists used slides (translations), flips (reflections), and turns (rotations) to create movement. Tell students they will work with tangrams to create an object and use translations to create movement of the object.
- Distribute tangrams or pattern blocks to students. Review the transformations with students by modeling them with objects.

A translation, or slide, moves a shape from one location to another without changing its orientation.

A rotation, or turn, causes a figure to rotate around a single point changing the orientation of the shape but not its size or shape.

A reflection, or flip, produces a mirror image of the shape. The shape's form and size are the same but the orientation and location are changed.

Ask students to select the shapes they will use to create an object. Allow them to practice translations with the shapes. They should draw the original shape on dot or graph paper and then draw the shape after the translation.

- Challenge the students to create an object with their shapes and use translations to create movement of the object, like the movie artists did in the video, recording their shapes and the translations on dot or graph paper.
 - Have students share their objects and the movement they created, explaining how they began and the translations they used to create the movement of the object.
5. Distribute two toothpicks to each student. Display the word angle. Ask students to create an angle with their toothpicks. Have them share and explain their angles. Review that angles are two rays that share an endpoint. Ask students to identify angles around the room.

Display the words parallel lines. Ask students to create parallel lines with their toothpicks. Have them share and explain their parallel lines. Review that parallel lines are two lines on the same plane that never intersect. Ask students to identify parallel lines around the room.

Display the words intersecting lines. Ask students to create intersecting lines with their toothpicks. Have them share and explain their intersecting lines. Review that intersecting lines

are lines that cross at a single point and form angles. Ask student to identify intersecting lines around the room.

Display the words perpendicular lines. Ask students to create perpendicular lines with their toothpicks. Have them share and explain their perpendicular lines. Review that perpendicular lines are two lines that intersect and form angles.

After reviewing angles, parallel line, intersecting lines, and perpendicular lines collect the toothpicks.

- Distribute a copy of a simple map or picture that has obvious angles, perpendicular lines, intersecting line, and parallel lines. Have students work with a partner to find as many examples of the different types of lines as they can in the map or picture. Ask each pair to share at least one example of each type they identified.
6. Display a variety of maps. Ask about the purpose of maps and have students share and explain their ideas. A map is a representation of an area that shows its main features. Maps show locations, provide directions, and help people navigate.

Draw students' attention to the map scale. Tell them the map scale is used to determine how far one location is from another. It shows how distances on the map relate to real distances, for example one inch on the map may equal 20 miles.

Distribute copies of a simple map. Ask students to identify the map scale. Model how to use the scale by measuring the distance from one location to another and using the map scale to convert the measurement into miles. If the distance from point A to point B is 3 inches and 1 inch equals 10 miles, then the distance from point A to point B is 30 miles. Continue modeling the use of the map scale until students can practice independently.

- Assign each student a partner. One partner should pick two locations on the map. Each student should use the map scale to determine the distance between the two locations. They should compare their answers to see if they are correct. Remind them to take turns identifying locations on the map.
- Have students explain, in writing, how they found the distance between two locations.
 - Extension: Have students plan a trip, using the map and map scale to determine the total distance they will travel.

Assessment

Use the following three-point rubric to evaluate students' work during this lesson.

- **3 points:** Students were highly engaged in class discussions; produced complete charts, including all requested information; clearly demonstrated the ability to describe and create two- and three-dimensional figures; clearly demonstrated the ability to identify and create similar and congruent shapes; clearly demonstrated the ability to identify and use transformations; clearly demonstrated an understanding of angles and perpendicular, parallel, and intersecting lines; clearly demonstrated the ability to use a map scale.

- **2 points:** Students participated in class discussions; produced adequate charts including most of the requested information; satisfactorily demonstrated the ability to describe and create two- and three-dimensional figures; satisfactorily demonstrated the ability to identify and create similar and congruent shapes; satisfactorily demonstrated the ability to identify and use transformations; satisfactorily demonstrated an understanding of angles and perpendicular, parallel, and intersecting lines; satisfactorily demonstrated the ability to use a map scale.
- **1 point:** Students participated minimally in class discussions; created an incomplete charts including little or none of the requested information; did not demonstrate the ability to describe and create two- and three-dimensional figures; did not demonstrate the ability to identify and create similar and congruent shapes; did not demonstrate the ability to identify and use transformations; did not demonstrate an understanding of angles and perpendicular, parallel, and intersecting lines; did not demonstrate the ability to use a map scale.

Vocabulary

angle

Definition: two rays that share an endpoint

Context: The student created an angle by drawing two rays that share an endpoint.

congruent

Definition: figures that have the same shape and size; all sides and angles are equal

Context: The two boys drew congruent figures that were the same shape and size and had equal sides and angles.

intersecting lines

Definition: two lines on the same plane that cross or meet at a point

Context: The girl drew two lines that crossed each other so they must be intersecting lines.

map scale

Definition: determines how far one location is from another on a map; the scale shows how distance on a map relates to real-world distances

Context: The teacher used the map scale to determine the distance from Orlando, Florida, to Atlanta, Georgia.

parallel lines

Definition: lines on the same plane that never intersect

Context: The two lines would never intersect so they must be parallel lines.

parallelogram

Definition: a four-sided figure whose opposite sides are parallel and equal

Context: The parallelogram had four opposite sides that were parallel and equal.

perpendicular lines

Definition: two lines that intersect and form a right angle

Context: The student drew two lines that intersected and formed a right angle so they must be perpendicular lines.

prism

Definition: three-dimensional shapes that have congruent sides that are parallelograms

Context: The building is the shape of a prism with congruent sides that are parallelograms.

pyramid

Definition: three-dimensional shapes that have four triangular faces and a square base

Context: The Egyptian pyramids have four triangular faces and a square base.

quadrilateral

Definition: a four-sided polygon

Context: The students drew several four-sided figures that were all quadrilaterals.

rectangle

Definition: a four-sided figure with opposite sides that are equal and parallel and four right angles

Context: The student drew a rectangle to represent the house. It had four sides, with opposite sides that were equal, and four right angles.

reflection

Definition: a transformation that produces a mirror image of the shape; the shape's form and size are the same but the orientation and location are changed

Context: The artist performed a reflection to create movement of the object.

rhombus

Definition: a parallelogram with four equal sides

Context: The girl drew a shape that had four equal sides with opposites sides parallel to each other. The teacher told the girl she had drawn a rhombus.

rotation

Definition: a transformation that causes a figure to rotate around a single point changing the orientation of the shape but not its size or shape

Context: The artist performed a rotation on the object, turning it around a single point.

similar

Definition: figures that have the same shape and proportions but have different sizes

Context: The teacher showed the class a square. She asked the students to draw similar figures. The students drew figures that had the same shape and proportions as the teacher's, but their figures were a different size.

sphere

Definition: a three-dimensional object that is shaped like a ball

Context: The shape of the Earth is a sphere.

square

Definition: a four-sided figure with four equal sides and four right angles

Context: The student drew a four-sided figure that had four equal sides and four right angles. The teacher said the student had drawn a square.

translation

Definition: a transformation that moves a shape from one location to another without changing its orientation or shape

Context: The artist performed a translation of the object by sliding it from one location to another without changing its orientation or shape.

trapezoid

Definition: a four-sided figure with exactly one pair of parallel sides

Context: The teacher asked her students the name of a four-sided figure with exactly one pair of parallel sides. The students told her the figure was a trapezoid.

triangle

Definition: a three-sided polygon

Context: The student drew a three-sided polygon and asked his partner to identify the shape. His partner correctly identified the shape as a triangle.

Academic Standards

Mid-continent Research for Education and Learning (McREL)

McREL's Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education addresses 14 content areas. To view the standards and benchmarks, visit

<http://www.mcrel.org/compendium/browse.asp>.

This lesson plan addresses the following benchmarks:

- Knows basic geometric language for describing and naming shapes (e.g., trapezoid, parallelogram, cube, sphere)
- Understands basic properties of figures (e.g., two- or three-dimensionality, symmetry, number of faces, type of angle)
- Predicts and verifies the effects of combining, subdividing, and changing basic shapes
- Understands that shapes can be congruent or similar
- Uses motion geometry (e.g., turns, flips, slides) to understand geometric relationships

- Understands characteristics of lines (e.g., parallel, perpendicular, intersecting) and angles (e.g., right, acute)

National Council of Teachers of Mathematics (NCTM)

The National Council of Teachers of Mathematics (NCTM) has developed national standards to provide guidelines for teaching mathematics. To view the standards online, go to <http://standards.nctm.org>.

This lesson plan addresses the following standards:

- Identify, compare, and analyze attributes of two- and three-dimensional shapes and develop vocabulary to describe the attributes
- Classify two- and three-dimensional shapes according to their properties and develop definitions of classes of shapes such as triangles and pyramids
- Investigate, describe, and reason about the results of subdividing, combining, and transforming shapes
- Explore congruence and similarity
- Predict and describe the results of sliding, flipping, and turning two-dimensional shapes
- Identify and describe line and rotational symmetry in two- and three-dimensional shapes and designs
- Recognize geometric ideas and relationships and apply them to other disciplines and to problems that arise in the classroom or in everyday life

Support Materials

Develop custom worksheets, educational puzzles, online quizzes, and more with the free teaching tools offered on the Discoveryschool.com Web site. Create and print support materials, or save them to a Custom Classroom account for future use. To learn more, visit

- <http://school.discovery.com/teachingtools/teachingtools.html>

DVD Content

This program is available in an interactive DVD format. The following information and activities are specific to the DVD version.

How to Use the DVD

The DVD starting screen has the following options:

Play Video – This plays the video from start to finish. There are no programmed stops, except by using a remote control. With a computer, depending on the particular software player, a pause button is included with the other video controls.

Video Index—Here the video is divided into chapters indicated by title. Each chapter is then divided into four sections indicated by video thumbnail icons; brief descriptions are noted for each section. To play a particular segment, press Enter on the remote for TV playback; on a computer, click once to highlight a thumbnail and read the accompanying text description and click again to start the video.

Quiz—Each chapter has four interactive quiz questions correlated to each of the chapter's four sections.

Standards Link—Selecting this option displays a single screen that lists the national academic standards the video addresses.

Teacher Resources—This screen gives the technical support number and Web site address.

Video Index

I. Shape Names (6 min.)

Shape Names: Introduction

Shapes can be three-dimensional or two-dimensional. Cones and spheres are three-dimensional. Squares, triangles, and rectangles are two-dimensional, flat, or plane shapes.

Example 1: Circles and Polygons

Circles are round shapes with a set of points the same distance from the center. Polygons are many-sided, closed figures with straight sides. Triangles, pentagons, octagons, and all quadrilaterals are polygons.

Example 2: Quadrilaterals

Quadrilaterals have four sides and angles. Squares have four equal sides and angles. Rhombuses have four equal sides. Parallelograms have opposite sides that are equal and parallel. Trapezoids have one pair of parallel sides.

Example 3: Three-Dimensional Shapes

Three-dimensional shapes take up space—they have depth, length, and height. Spheres, pyramids, and prisms are examples.

II. Properties of Geometric Figures (8 min.)

Properties of Geometric Figures: Introduction

Angles, number of sides, symmetry, and dimensionality are properties of geometric figures.

Example 1: Two-Dimensional Shapes

Geometric shapes and angles are used in architectural designs. Right, acute, and obtuse angles are used to create two-dimensional shapes.

Example 2: Three-Dimensional Shapes

Pyramids are three-dimensional shapes that have four triangular faces and a square base. Prisms are three-dimensional shapes that have congruent sides that are parallelograms.

Example 3: Bilateral Symmetry

Bilateral symmetry is when one half of a shape is a mirror image of the other half. The line, or plane, of symmetry divides a shape into two symmetrical sides. Animals and humans have symmetrical features.

III. Altering Shapes (7 min.)

Altering Shapes: Introduction

Shapes can be divided, combined, or changed to make other shapes. Subdividing is when a line is drawn inside a shape to create two new shapes. Shapes can be combined to create a new shape.

Example 1: Subdividing Shapes

Examples of shapes that have been subdivided are shown and explained. Landscape architects often subdivide shapes to create exotic gardens. Shapes can be subdivided in an infinite number of ways.

Example 2: Combining Shapes

Examples of two-dimensional shapes that have been combined to form more complex shapes are shown and explained. Shapes can be combined in an infinite number of ways.

Example 3: Changing Shapes

Shapes can be manipulated to create new designs. Folding a rectangular flag into a triangle is one example of changing a shape.

IV. Congruent and Similar Shapes (8 min.)

Congruent and Similar Shapes: Introduction

Congruent figures have the same shape and size. Similar figures have the same shape and proportions but different size sides.

Example 1: Congruence

Congruence is defined and examples are shown. Figures with the same size sides and angles are congruent.

Example 2: Similarity

Similar shapes are defined and modeled. Two figures are similar if they have the same shape and corresponding angles but are not the same size. Similar figures must have the same proportions.

Example 3: Congruence and Similarity

Examples of congruent and similar figures are shown. All congruent figures are similar, but not all similar figures are congruent.

V. Motion Geometry (7 min.)

Motion Geometry: Introduction

Geometric shapes can be transformed with translations, rotations, or reflections. Transformations allow figures to move by altering their orientation, size, or shape.

Example 1: Translations, or Slides

Artists use geometric transformations to create images of dinosaurs walking. A translation, or slide, moves a shape from one location to another without changing its orientation, size, or shape.

Example 2: Rotations, or Turns

Artists use rotations, or turns, to create images of dragons flying and falling. A rotation causes a figure to move around a single point, changing the orientation of the shape but not its size or shape.

Example 3: Reflections

Artists use reflections, or flips, to create dinosaurs and dragons. Reflections produce mirror images of shapes. The shape's form and size are the same, but the orientation and location are changed.

VI. Lines and Angles (5 min.)

Lines and Angles: Introduction

Many shapes are made up of lines. Lines, line segments, rays, and angles are introduced, defined, and modeled.

Example 1: Parallel Lines

Parallel lines never intersect. Examples are train tracks or lines separating highway lanes.

Example 2: Perpendicular Lines

Perpendicular lines intersect and form 90-degree angles. Examples of perpendicular lines are modeled.

Example 3: Intersecting Lines

Intersecting lines cross at a single point and form angles. Examples of intersecting lines are modeled. Acute and obtuse angles are defined and modeled.

VII. Maps and Drawing Scales (7 min.)

Maps and Drawing Scales: Introduction

A map is a representation of an area that shows its main features. Maps show locations and help people navigate. Weather maps locate and track storms and are used to predict weather.

Example 1: Description of Map and Scale

Maps and map scales are used to determine distances between locations. Map scales show how distances on a map relate to real distances. Using a map scale is modeled.

Example 2: Diversity of Maps and Scales

Maps are drawn to represent large and small areas. The most important aspect of a map is its clear representation of a given area and the relationships within that area.

Example 3: Calculation of Distance

Hikers use a map and map scale to determine the total distance of a hike. They measure the distance on the map, compare it to the scale, and convert it to miles.

Quiz

I. Shape Names

1. Identify the three-dimensional shape.
A. cone
B. circle
C. triangle
D. rectangle

Answer: A

2. John sees a polygon with five sides. What is the name of the shape?
A. square
B. octagon
C. triangle
D. pentagon

Answer: D

3. Identify the quadrilateral that has only one pair of parallel sides.
A. square
B. rhombus
C. trapezoid
D. parallelogram

Answer: C

4. What three-dimensional shape is a volleyball?
A. cone
B. prism
C. sphere
D. pyramid

Answer: C

II. Properties of Geometric Figures

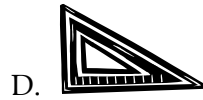
1. Deana is designing a building. She wants to add a design using a three-sided polygon to the outside wall. What figure is Deana going to add to the wall?
A. circle
B. B square
C. triangle
D. rectangle

Answer: C

2. Identify the three-dimensional shape that has four triangular faces and a square base.
A. cone
B. prism
C. sphere
D. pyramid

Answer: D

3. Which shape is symmetrical?



Answer: B

III. Altering Shapes

1. What shape is formed when two squares are combined?



- A. oval
- B. circle
- C. triangle
- D. rectangle

Answer: D

2. Harry wants to subdivide a pentagon. What two shapes will Harry have once he has subdivided the pentagon?
A. circle and square

- B. triangle and square
- C. trapezoid and square
- D. triangle and trapezoid

Answer: D

3. Identify two shapes that were combined to create the design.



- A. hexagons and pentagons
- B. octagons and triangles
- C. rhombuses and triangles
- D. pentagons and rectangles

Answer: C

4. What shape is created when a square is tilted?
- A. circle
 - B. ellipse
 - C. triangle
 - D. rhombus

Answer: D

IV. Congruent and Similar Shapes

1. Two figures are congruent if they have ____.
- A. the same shape and the same size sides and angles
 - B. the same shape and different size sides and angles
 - C. different shapes and the same size sides and angles
 - D. different shapes and different size sides and angles

Answer: A

2. Mary has two figures. They have the same proportions and are the same shape, but they are different sizes. What type of shapes does Mary have?
- A. equal shapes
 - B. similar shapes
 - C. congruent shapes
 - D. symmetrical shapes

Answer: B

3. Which statement is true about congruent and similar figures?
 - A. All congruent figures are similar.
 - B. All similar figures are congruent.
 - C. All congruent figures are symmetrical.
 - D. All similar and congruent figures are two-dimensional.

Answer: A

V. Motion Geometry

1. Which transformation moves a shape from one location to another without changing its orientation, size, or shape?
 - A. rotation
 - B. reflection
 - C. translation
 - D. symmetrical motion

Answer: C

2. Which geometric transformation causes a figure to move around a single point, changing the orientation of the figure but not its size or shape?
 - A. rotation
 - B. reflection
 - C. translation
 - D. symmetrical motion

Answer: A

3. Which geometric transformation produces a mirror image of a shape, changing its orientation but not its size and shape?
 - A. rotation
 - B. reflection
 - C. translation
 - D. symmetrical motion

Answer: B

VI. Lines and Angles

1. What is formed when two line segments have a common endpoint?
 - A. line
 - B. angle
 - C. square
 - D. symmetry

Answer: B

2. What word describes the two lines?



- A. parallel
- B. unequal
- C. intersecting
- D. perpendicular

Answer: A

3. Barbara draws two lines that intersect and form a 90-degree angle. What type of lines did she draw?

- A. parallel
- B. unequal
- C. intersecting
- D. perpendicular

Answer: D

4. Two lines intersect and form a 32-degree angle. What type of angle do the lines form?

- A. right angle
- B. acute angle
- C. obtuse angle
- D. symmetrical angle

Answer: B

VII. Maps and Drawing Scales

1. What type of map is used to locate and track storms?

- A. city map
- B. subway map
- C. weather map
- D. tracking map

Answer: B

2. Laura is trying to find the distance between New York City and St. Louis, Missouri. The distance from New York City to St. Louis is almost 5 inches on the map. The map scale shows that 1 inch = 200 miles. What is the distance from New York City to St. Louis?

- A. about 100 miles
- B. about 500 miles
- C. about 1,000 miles
- D. about 2,000 miles

Answer: C

3. A group of hikers is using a map and the map scale to determine the distance they will hike. They are traveling from point A to point B, and then back to point A. The hikers measure 2 inches between point A and point B on the map. The map scale shows that 1 inch = 2 miles. How far will the hikers travel?
- A. 4 miles
 - B. 6 miles
 - C. 8 miles
 - D. 10 miles

Answer: C

Shape Chart

Geometric Shape	Properties of Shape

Geometric Shape Cards

<p>square</p> <p>a four-sided figure with four equal sides and four right angles</p>	<p>triangle</p> <p>a three-sided polygon</p>
<p>rectangle</p> <p>a four-sided figure with opposite sides that are equal and parallel and four right angles</p>	<p>pentagon</p> <p>a five-sided figure</p>
<p>octagon</p> <p>an eight-sided figure</p>	<p>rhombus</p> <p>a parallelogram with four equal sides</p>
<p>parallelogram</p> <p>a four-sided figure whose opposite sides are parallel and equal</p>	<p>trapezoid</p> <p>a four-sided figure with exactly one pair of parallel sides</p>