

What's Your Design?

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Approximate Timeline: Varies by grade level

Area(s) of Core Content: Mathematics (Geometry)

Organizers:

How are two and three-dimensional shapes used in design in real world situations?

Targeted Standards and Demonstrators:

1.5 - 1.9 Students use mathematical ideas and procedures to communicate, reason, and solve problems.

- *Communicate the meanings of number, space, change, data, and measurement verbally, pictorially, symbolically, and concretely.*

2.9 Students understand space and dimensionality concepts and use them appropriately and accurately.

- *Use attributes to classify and analyze regular and irregular figures in 2 and 3 dimensions.*
- *Use a coordinate system to define and locate position.*
- *Investigate symmetry, similarity, and congruence using concrete models and drawing.*
- *Visualize different representations of 2 and 3-dimensional geometric figures.*

5.2 Students use creative thinking skills to develop or invent novel, constructive ideas or products.

- *Create a new solution/idea/product.*

Secondary Standard and Demonstrators:

1.16 Students use computers and other kinds of technology to collect, organize, and communicate information and ideas.

- *Integrate the use of a variety of technologies.*
- *Expand knowledge by identifying and using technology for a specific purpose.*

6.3 Students expand their understanding of existing knowledge by making connections with new knowledge, skills, and experiences.

- *Discover relationships among existing knowledge and new ideas, objects, and actions.*
- *Analyze the connections between new and existing knowledge in specific situations.*

Essential Questions:

Grade Six:

1. What are the basic terms and shapes used in geometry?
2. How can you measure two-dimensional shapes?
3. What are the angle relationships of two-dimensional figures?

Grade Seven:

1. What are the characteristics of angles?
2. What are the characteristics of two-dimensional shapes?
3. What are the angle relationships of two-dimensional figures?
4. How is proportionality used to create scale drawings?

Grade Eight:

1. How do three-dimensional shapes look from different viewpoints?
2. How are scale drawings and models developed?

Culminating Performance:

Sixth Grade:

Students will design a stained glass window. They will submit an initial plan detailing the measurements of all lines and angles of the window. It must incorporate at least four different geometric shapes and have at least one line of symmetry.

Seventh Grade:

Students will create a scale drawing of their own geometric family of four members (similar to the Wumps from *Stretching and Shrinking*, Dale Seymour Publications). A chart listing coordinates for each family member must be included. First, you must create the seventh grade character on a coordinate grid. Second, transform the seventh grade character into three other characters using the teacher-provided scale factors.

Eighth Grade:

Students will design and create a three-dimensional multi-room building. Initially students will submit hand-drawn floor plans and technology created elevations

(side views). Utilizing these plans, the students will build a three-dimensional scale model of their structure.

Evaluation Component:

Sixth Grade:

Pre/Post test over the sixth grade concepts from the Program of Studies from this unit.

Seventh Grade:

Pre/Post test over the seventh grade concepts from the Program of Studies from this unit.

Eighth Grade:

Pre/Post test over the eighth grade concepts from the Program of Studies from this unit.

Core Content/Knowledge:

- MA-M-2.1.1 Basic geometric elements that include points, segments, rays, lines, angles, and planes
- MA-M-2.1.2 Two-dimensional shapes including circles, regular polygons, quadrilaterals (square, rectangle, rhombus, parallelogram, trapezoid), and triangles (acute, obtuse, right, equilateral, scalene, isosceles)
- MA-M-2.1.4 Congruence, symmetry, and similarity
- MA-M-2.2.1 Identify characteristics (e.g., sides, vertices, angles, faces, edges, congruent parts) of two-dimensional and three-dimensional shapes
- MA-M-2.2.6 Estimate and determine measurement of angles
- MA-M-2.3.2 How two-dimensional and three-dimensional figures are related as seen in different orientations (e.g., top view, side view, three-dimensional shapes drawn on isometric dot paper)
- MA-M-2.3.3 How proportional figures are related (scale drawings, similar figures)
- Area
- Perimeter

Skills/Abilities:

- Read and use measurement tools (e.g., rulers, scales).
- Estimate and find angle measurement and segment measurements.
- Formulate the rule that the sum of angle measurements is 180 degrees in a triangle and 360 degrees in a quadrilateral.
- Identify properties and classify line segments, rays, planes, and points.

- Recognize regular polygons; special quadrilaterals including squares, rectangles, rhombuses, trapezoids, and parallelograms; and special triangles including acute, obtuse, scalene, and isosceles.
- Identify characteristics of lines (e.g., parallel, perpendicular).
- Use lines of symmetry and sketch plane figures with multiple lines of symmetry.
- Identify and classify characteristics of two-dimensional shapes, such as regular and irregular quadrilaterals, special triangles, and regular polygons.
- Identify characteristics of angles (e.g., adjacent, vertical, corresponding, interior, exterior).
- Represent three-dimensional geometric figures with special attention to developing spatial sense (e.g., top view, side view, three-dimensional shapes drawn on isometric dot paper).
- Develop and apply proportionality and relationships between scale models and actual figures.
- Investigate transformations' congruence, proportionality, and similarity (e.g., enlargements, reductions, proportional triangles) in a coordinate plane.
- Basic computation skills using whole numbers, fractions, and decimals
- Use technology tools [Geometer's Sketchpad, Computer Assisted Design (CAD)]

Critical Resources:

Stained glass examples and materials (crayons, tissue paper, etc.)

Guest speakers (architects, engineers, interior designers, ...)

Software and training on Geometer's Sketchpad, CAD

Computers

Internet

- Illuminations: <http://illuminations.nctm.org/index2.html>
- Shodor: <http://www.shodor.org/>

LCD Projector

Protractors

Rulers

Angle rulers

Model building materials (balsa wood, sugar cubes, Popsicle sticks, foam board)

Isometric dot paper

Graph paper

Linking cubes

Shapes sets (from Connected Mathematics Project, Dale Seymour Publications)

Geoboards

Polystrips

Brass fasteners

Graphing calculator

Rubberbands
 Masking tape
 Scissors
 Colored pencils
 Grid paper
 Transparency markers

Technology Standards:

T1.1 Demonstrate ethical use of electronic resources
 T5.10 Use other electronic devices to process information
 T6.1 Select appropriate software for a task.

Instructional/Assessment Activities:

6th grade

Topic 1

Objective:

- Students will be able to define basic geometric terms: point, line, line segment, ray, plane, circles, chords, diameters, radius, and circumference.

Description:

- Introduce basic geometric terms: point, line, line segment, ray, plane circles, chords, diameters, radius, and circumference using Geometer's Sketchpad and Geoboards.

Assessment:

- Teacher Observation of Class work/ Embedded Teachers Questions

Topic 2

Objective:

- Students will discover polygons (regular and irregular) that can be used to tile a plane.

Description:

- Shapes and Designs (Investigation 1)

Assessment:

- Teacher Observation of Class work/ Embedded Teachers Questions and ACE Assignments

Topic 3

Objective:

- Students will explore the way that edge lengths determine the shapes of polygons.
- Students will recognize and classify polygons: special triangles, special quadrilaterals, and regular polygons.

Description:

- Shapes and Designs (Investigation 2) Use polystrips to build triangles and quadrilaterals.

Assessment:

- Teacher Observation of Class work/ Embedded Teachers Questions and ACE Assignments

Topic 4

Objective:

- Students will explore angle measures.
- Students will estimate angle measures using benchmarks and precise angle measure using angle rulers.

Description:

- Shapes and Designs (Investigation 3 & 4)

Assessment:

- Teacher Observation of Class work/ Embedded Teachers Questions, ACE Assignments, Check-up #1 (Shapes & Designs)

Topic 5

Objective:

- Students will be introduced to culminating project and the scoring rubric.

Description:

- Students will be shown sample projects after receiving assignment. Students will begin working on their projects.

Assessment:

- Culminating Project Rubric

7th grade*Topic 1*

Objective:

- Students will explore relationships between lengths and in between areas in simple, similar figures.

Description:

- Stretching and Shrinking, Investigation 1

Assessment:

- Teacher Observation of Class work/ Embedded Teachers Questions; ACE Assignments

Topic 2

Objective:

- Students will graph figures using algebraic rules; to learn that corresponding angles of similar figures are equal and that corresponding

sides grow by the same factor; to compare lengths and angles in similar and non-similar figures informally.

Description:

- Stretching and Shrinking, Investigation 2

Assessment:

- Teacher Observation of Class work/ Embedded Teachers Questions; ACE Assignments, Check-up #1 (Stretching and Shrinking)

Topic 3

Objective:

- Students will be introduced to culminating project and the scoring rubric.

Description:

- Students will be shown sample projects after receiving assignment. Students will begin working on their projects.

Assessment:

- Culminating Project Rubric

8th Grade

Topic 1

Objective:

- Students will draw sets of plans for cube buildings.

Description:

- Investigation 1, Ruins of Montarek

Assessment:

- Teacher Observation of Class work/ Embedded Teachers Questions; ACE Assignments

Topic 2

Objective:

- Students will build cube models from sets of plans.

Description:

- Investigation 2, Ruins of Montarek

Assessment:

- Teacher Observation of Class work/ Embedded Teachers Questions; ACE Assignments

Topic 3

Objective:

- Students will learn to use isometric dot paper to more realistically draw three-dimensional buildings.

Description:

- Investigation 4, Ruins of Montarek

Assessment:

- Teacher Observation of Class work/ Embedded Teachers Questions; ACE Assignments, Check-up #1

Topic 4

Objective:

- Students will learn to relate isometric drawings of buildings to sets of building plans.

Description:

- Investigation 5 & 6, Ruins of Montarek

Assessment:

- Teacher Observation of Class work/ Embedded Teachers Questions; ACE Assignments, Check-up #2

Topic 5

Objective:

- Students will draw using technology software like CAD to draw two- and three-dimensional buildings.

Description:

- Students will use computers in the computer lab to learn how to use CAD.

Assessment:

- Teacher Observation of Class work/ Embedded Teachers Questions

Topic 6

Objective:

- Students will be introduced to culminating project and the scoring rubric.

Description:

- Students will be shown sample projects after receiving assignment. Students will begin working on their projects.

Assessment:

- Culminating Project Rubrics

Scoring Guide**Unit Title:** Geometry**Culminating Performance:*****Sixth Grade:***

Students will design a visually attractive stained glass window. They will submit an initial plan detailing the measurements of all line segments and angles of the window. It must incorporate at least four different geometric shapes and have at least one line of symmetry.

Criteria	4	3	2	1
Required number of geometric shapes	More than four different geometric shapes	Four different geometric shapes	Two to three different geometric shapes	One or no geometric shapes
Symmetry	Accurately incorporates more than one line of symmetry	Accurately incorporates one line of symmetry	Attempted but incorrect line of symmetry	No attempt at line of symmetry
Initial Plan	Contains accurate measurements of all line segments and angles.	Contains mostly accurate measurements of all line segments and angles.	Contains some accurate measurements of all line segments and angles.	Contains few or no accurate measurements of all line segments and angles.
Visual Appearance	The window is exceptionally attractive in terms of design, layout, color, and neatness.	The window is attractive in terms of design, layout, color, and neatness.	The window is acceptably attractive though it may be a bit messy.	The window is distractingly messy or very poorly designed. It is not attractive.

Seventh Grade:

Students will create a scale drawing of their own geometric family of four members (similar to the Wumps from *Stretching and Shrinking*, Dale Seymour Publications). A chart listing coordinates for each family member must be included. First, you must create the seventh grade character on a coordinate grid. Second, transform the seventh grade character into three other characters using the teacher-provided scale factors.

Criteria	3	2	1
Proportions	All figures are accurately drawn using the given scale.	All figures are drawn with minor errors.	Incorrect solution or incomplete solution.
Completeness	All four figures completely drawn.	Three figures completely drawn.	One or two figures completely drawn.
Number of coordinates used to create original character	Above 40 coordinates	31-40 coordinates	At least 30 coordinates
Visual Appearance	The characters are exceptionally attractive in terms of design, layout, color, and neatness.	The characters are attractive in terms of design, layout, color, and neatness.	The characters are distractingly messy or very poorly designed. They are not attractive.
Coordinate chart	All coordinates are accurate.	All coordinates are listed with minor errors.	Incorrect solution or incomplete solution.

Eighth Grade:

Students will design and create a three-dimensional multi-room building. Initially students will submit hand-drawn floor plans and technology created elevations (side views). Utilizing these plans, the students will build a three-dimensional scale model of their structure.

Plans Rubric:

Criteria	4	3	2	1
Design	The design creatively and accurately reflects the building's purpose.	The design accurately reflects the building's purpose.	The design somewhat accurately reflects the building's purpose.	The design does not reflect the building's purpose.
Floor Plan	Plan is neat with correct measurements and labeling for all components.	Plan is neat with correct measurements and labeling for most components.	Plan provides correct measurements and labeling for some components.	Plan does not show correct measurements or is otherwise inadequately labeled.
Plan Components	Complete floor plan and 4 side views.	Complete floor plan and 3 side views.	Complete floor plan and 1 or 2 side views.	Complete floor plan only or 2 or more side views.
Technology	Utilizes technology to create four accurate elevations.	Utilizes technology to create four elevations with minor errors.	Utilizes technology to create three elevations.	Utilizes technology to create one to two elevations.

Three-dimensional Model Rubric:

Criteria	4	3	2	1
Design	The design creatively and accurately reflects the buildings purpose.	The design accurately reflects the buildings purpose.	The design somewhat accurately reflects the buildings purpose.	The design does not reflect the buildings purpose.
Model Measurements and labels	Plan is neat with correct measurements and	Plan is neat with correct measurements and labeling	Plan provides correct measurements and labeling	Plan does not show correct measurements or is

	labeling for all components.	for most components.	for some components.	otherwise inadequately labeled.
Neatness	The model is exceptionally attractive in terms of design, detail, layout, and neatness.	The model is attractive in terms of design, detail, layout, and neatness.	The model is somewhat attractive in terms of design, detail, layout, and neatness.	The model is not attractive in terms of design, detail, layout, and neatness.