Georgia Performance Standards Framework for Mathematics – Grade 2

Unit 4 Organizer: "PLANE AND SOLID FIGURES" (4 weeks)

OVERVIEW:

In this unit students will:

- further develop understandings of basic geometric figures;
- identify plane figures and solid figures based on geometric properties;
- describe plane figures and solid figures according to geometric properties;
- develop an understanding of the inner-relatedness of solid figures and plane figures;
- cultivate spatial awareness;
- investigate the outcomes when geometric figures are combined;
- investigate the outcomes when geometric figures are cut apart; and
- expand the ability to see geometry in the real world.

Although the units in this instructional framework emphasize key standards and big ideas at specific times of the year, routine topics such as counting, time, money, positional words, patterns and tallying should be addressed on an ongoing basis through the use of calendar, centers, and games. This first unit should establish these routines, allowing students to gradually understand the concept of number and time.

To assure that this unit is taught with the appropriate emphasis, depth, and rigor, it is important that the tasks listed under "Evidence of Learning" be reviewed early in the planning process. A variety of resources should be utilized to supplement, but not completely replace, the textbook. Textbooks not only provide much needed content information, but excellent learning activities as well. The tasks in these units illustrate the types of learning activities that should be utilized from a variety of sources.

Georgia Performance Standards Framework for Mathematics – Grade 2

ENDURING UNDERSTANDINGS:

- Geometric figures can be classified according to their properties.
- Acute, right, and obtuse angles can be identified based upon appearance.
- Geometric figures can be manipulated to create different geometric figures.
- Geometric figures are a significant part of our environment.

ESSENTIAL QUESTIONS:

- How are plane figures and solid figures related? How are they different?
- Where can we find geometric figures in the world around us?
- How do we describe geometric figures?
- What are angles?
- What happens when I put geometric figures together?
- What will I see if I cut apart geometric figures?

STANDARDS ADDRESSED IN THIS UNIT

Mathematical standards are interwoven and should be addressed throughout the year in as many different units and activities as possible in order to emphasize the natural connections that exist among mathematical topics.

KEY STANDARDS:

M2G1. Students will describe and classify plane figures (triangles, square, rectangle, trapezoid, quadrilateral, pentagon, hexagon, and irregular polygonal shapes) according to the number of edges and vertices and the sizes of angles (right angle, obtuse, acute).

M2G2. Students will describe and classify solid geometric figures (prisms, cylinders, cones, and spheres) according to such things as the number of edges and vertices and the number and shape of faces and angles.

a. Recognize the (plane) shapes of the faces of a geometric solid and count the number of faces of each type.
b. Recognize the shape of an angle as a right angle, an obtuse or acute angle.

M2G3. Students will describe the change in attributes as two and three-dimensional shapes are cut and rearranged.

RELATED STANDARDS:

M2P1. Students will solve problems (using appropriate technology).

a. Build new mathematical knowledge through problem solving.
b. Solve problems that arise in mathematics and in other contexts.
c. Apply and adapt a variety of appropriate strategies to solve problems.
d. Monitor and reflect on the process of mathematical problem solving.

M2P2. Students will reason and evaluate mathematical arguments.

a. Recognize reasoning and proof as fundamental aspects of mathematics.
b. Make and investigate mathematical conjectures.
c. Develop and evaluate mathematical arguments and proofs.
d. Select and use various types of reasoning and methods of proof.

M2P3. Students will communicate mathematically.

a. Organize and consolidate their mathematical thinking through communication.
b. Communicate their mathematical thinking coherently and clearly to peers, teachers, and others.
c. Analyze and evaluate the mathematical thinking and strategies of others.
d. Use the language of mathematics to express mathematical ideas precisely.

M2P4. Students will make connections among mathematical ideas and to other disciplines.

a. Recognize and use connections among mathematical ideas.
b. Understand how mathematical ideas interconnect and build on one another to produce a coherent whole.
c. Recognize and apply mathematics in contexts outside of mathematics.

M2P5. Students will represent mathematics in multiple ways.

a. Create and use representations to organize, record, and communicate mathematical ideas.
b. Select, apply, and translate among mathematical representations to solve problems.
c. Use representations to model and interpret physical, social, and mathematical phenomena.

CONCEPTS/SKILLS TO MAINTAIN:

It is expected that students will have prior knowledge/experience related to the concepts and skills identified below. It may be necessary to pre-assess in order to determine if time needs to be spent on conceptual activities that help students develop a deeper understanding of these ideas.

- Fluency with single digit addition/subtraction facts to 18
- Fair trades with coins or bills
- Duration and sequence of events
- Number patterns-skip count, odd/even
- Fact families
- Fractions: halves, fourths
- Tally marks
- Picture graphs
- Estimation: rounding to nearest ten
- Telling time
- Measurement – estimating, comparing, and ordering
- Basic geometric figures and spatial relationships

SELECTED TERMS AND SYMBOLS:

The following terms and symbols are often misunderstood. These concepts are not an inclusive list and should not be taught in isolation. However, due to evidence of frequent difficulty and misunderstanding associated with these concepts, instructors should pay particular attention to them and how their students are able to explain and apply them.

The definitions below are for teacher reference only and are not to be memorized by the students. Teachers should present these concepts to students with models and real life examples. Students should understand the concepts involved and be able to recognize and/or demonstrate them with words, models, pictures, or numbers.

Plane figure: A figure of which all points lie in the same plane. Plane figures included in the Grade 2 GPS are triangles, square, rectangle, trapezoid, quadrilateral, pentagon, hexagon, and irregular polygons.
Polygon: A closed plane figure (no gaps or openings) made of 3 or more sides and angles.
Trapezoid: A quadrilateral with two parallel sides.
Quadrilateral: A four-sided polygon.
Pentagon: A five-sided polygon.
Hexagon: A six-sided polygon.
Regular Polygon: A polygon that is equiangular (all of the angles are congruent) and equilateral (all of the sides are congruent).
Irregular Polygon: A polygon that has sides and angles of differing sizes.
Solid figure: A three-dimensional figure. Solid figures in the Grade 2 GPS include prisms, cylinders, cones, and spheres.
Sphere: A three-dimensional figure with all points equidistant from the center (examples include a basketball or a globe).
Edges: The sides of a geometric figure
Vertices: The corners of a geometric figure
Face: The plane figure(s) that make up a solid figure.

EVIDENCE OF LEARNING:

By the conclusion of this unit, students should be able to demonstrate the following competencies:

- Describe plane figures according to the defining features (edges, corners, angles)
- Describe solid figures according to the defining features (faces, edges, vertices)
- Describe and understand the relationships (commonalities and differences) between solid figures and plane figures
- Recognize the relationship between geometry and the environment
- Compare geometric figures to similar objects in everyday life
- Identify right, acute, and obtuse angles within geometric figures
- Understand that irregular polygons are classified according to the number of sides and angles.

The following tasks represent the level of depth, rigor, and complexity expected of all second grade students. These tasks or a task of similar depth and rigor should be used to demonstrate evidence of learning.

- What's in a Name?
- Riddle Me This, Riddle Me That
- Simon Sees Human Angles
- Cereal Boxes
- Crazy Polygons
- 3-D Detective
- Clay Cones
- My Favorite Space Figure
- My Dream Home/Castle

Culminating Activity: "My Dream Home/Castle"
Students will represent and explain all of the geometry that they can find in the "architecture" of a castle and/or dream home that they create out of solid figures.

STRATEGIES FOR TEACHING AND LEARNING:

- Students should be actively engaged by developing their own understanding.
- Mathematics should be represented in as many ways as possible by using graphs, tables, pictures, symbols and words.
- Appropriate manipulatives and technology should be used to enhance student learning.
- Students should be given opportunities to revise their work based on teacher feedback, peer feedback, and metacognition which includes self-assessment and reflection.

Classroom Routines

The importance of continuing the established classroom routines cannot be overstated. Daily routines must include such obvious activities such as taking attendance, doing a lunch count, determining how many items are needed for snack, lining up in a variety of ways (by height, age, type of shoe, hair color, eye color, etc.), daily questions and calendar activities. They should also include less obvious routines, such as how to select materials, how to use materials in a productive manner, how to put materials away, how to open and close a door, how to do just about everything! An additional routine is to allow plenty of time for children to explore new materials before attempting any directed activity with these new materials. The regular use of the routines are important to the development of students' number sense, flexibility, and fluency, which will support students' performances on the tasks in this unit. See unit 1 for suggestions concerning specific ideas for classroom routines.

TASKS:

The collection of the following tasks represents the level of depth, rigor and complexity expected of all second grade students to demonstrate evidence of learning.

- **What's in a Name?**

What's in a Name?

1. Print your name in large block letters on the paper.
2. Find and label all of the different types of angles, shapes and other geometric figures that are in your name.
3. When you are finished labeling, write everything that you know about the geometry found in your name.

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Discussion, Suggestions, Possible Solutions

Materials: large paper (8 ½ x 14 or larger), geoboards, rubber bands

Before presenting the task, have the students participate in the following introductory and review activities. Read a story such as The Silly Story of Goldilocks and the Three Squares *by Grace MacCarone to review common geometric features.*

Use geoboards to review creating and discussing common plane figures and angles:
Examples: Use two rubber bands to create an obtuse angle. What words could be used to describe the angle. Create a hexagon. How could you describe this figure to a new student? Etc.

Take "Geometry Walk" through the classroom or school to identify geometric figures within their environment. Explain to students that they will now find the geometry hidden in their own names.

Time saving tips: Write or type students' names on large paper in advance or use large copies of the schools' name as an alternate word.

Since each student's name is different, answers will vary greatly. A student who recognizes polygons and angles will label many parts of each letter in his or her name. It is normal to see a child turning his or her paper to look for polygons or angle that they missed while looking at the letters in the name from the normal direction. Common extensions of the activity include comments from students pointing out parts of their names that are not polygons or angles. For example, "The inside of the P has a curved line, so it is not a polygon." "

- **Riddle Me This, Riddle Me That**

Riddle Me This, Riddle Me That

- Explore the 3-D shapes on your table.
- With your partner, write the name of each geometric solid.
- Write how many faces, vertices, and edges it has.
  Remember:
  - A face is a flat surface.
  - An edge is where two faces meet.
  - A vertex is where three faces meet.

After your chart is filled in, write a riddle for 3 different 3-D shapes in your math journal. We will share these as a class and try to guess the shapes being described.

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Discussion, Suggestions, Possible Solutions

Allow students to explore the 3-D solid figures (these can be ones that have been made or purchased). Demonstrate how to find a face, vertex, and edge. Encourage them to use their sense of touch as they repeat what these terms mean. The sphere may be tricky for some students, but reminding them to use their sense of touch while thinking of the definition of what each word means will help them.

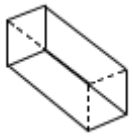
After students have filled in their charts together, allow them to come up with 3-D riddles about their shapes. They will share these with the class and allow the partners to guess which shape was being described in the riddle.
For example:

My number of faces, vertices, and edges are all the same.
Zero is that number, can you guess my name?
Answer: Sphere

Allow students to share their riddles and use their charts to find the answers to the riddles.

See the chart below.

	3-D Shape picture	**3-D Shape name**	**# of Faces** A face is a flat surface.	**# of Vertices** A vertex is where three faces meet.	**# of Edges** An edge is where two faces meet.
1.					

2.					
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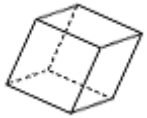
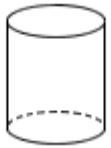
4.					
5.					
6.					

- **Simon Sees Human Angles**

Simon Sees Human Angles

Sit on the floor in a large circle with your classmates.
Stretch your legs straight out in front of you.
As you move your feet so that your toes move away and toward you, watch what happens to the space between your foot and your leg.
Talk with your classmates and your teacher about what you see.
Now try the same thing using your hand and arm.
Now you are ready to play "Simon Sees Human Angles".
Listen as your teacher calls out the name of an angle and make it as quickly as you can using either your foot and leg or your hand and arm.
Be sure the teacher says, "Simon Sees…" before you move!

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Discussion, Suggestions, Possible Solutions

Ask your students what the word angle sounds like. Hint: It's part of your body. Invariably, they will figure out that you're referring to the ankle. Explain that the word angle *sounds like the word* ankle, *and that your foot makes an angle with your leg. Show them with your ankle a 90^{o} angle. Next, show them an acute angle by pulling your toes up toward your shin. Say acute with a very high pitched voice. Last, show them an obtuse angle by pointing your toes and stretching them away from your shin. Say obtuse with a big, deep voice. Allow the students to try showing the angles with their ankles as you say the words "right angle"," acute angle", or "obtuse angle". The regular, high pitched, and deep voices help them to make a verbal connection to the size. Ask the students if the length of their foot/hand changes the size of the angle. Why or why not? Talk with the students about the fact that an angle represents the size of the opening made by your foot/hand.*

For the next activity, have the students stretch out so that they can put their arms out straight on both sides and not touch anyone. Ask them to demonstrate a 90^o angle (right angle). Continue with the acute and obtuse angles (using the voices). Explain that you are going to play "Simon Sees" and they will need to demonstrate the angle that Simon says. Play this game a few different times and allow the winner to be Simon.

After the game has been played ask the students to locate at least one example of each type of angle (right, obtuse, and acute) in the classroom. Have them write about each example and include a drawing of the example in their math journal. Students should use the correct vocabulary to name each angle.

- **Crazy Polygons**

Crazy Polygons

Use dot paper to create as many Polygons as you can.
Be sure to label the names of each of your polygons.
Pick out your favorites and write an explanation of how you know that you've labeled them correctly.

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Discussion, Suggestions, Possible Solutions

Begin this lesson by asking students to define polygon. Make a polygon chart labeled examples and non-examples. After drawing a few examples and non-examples, ask students to create a definition.

Discuss how the various polygons you drew on the t-chart are classified according to the number of edges and vertices they have. Explore examples of irregular polygons. Post the names of polygons to increase student interest. They can be found at mathcentral.uregina.ca/QQ/database/QQ.09.96/rosa1.html.

Possible solutions will include polygons that fit the definition with a written explanation that proves that the child understands that irregular polygons are named according to the number edges and vertices. A common mistake is to draw a figure with lines that run through the middle thereby creating two or more adjoined polygons. Occasionally a student will question whether or not to count a concave vertex. To avoid this, include a polygon with a concave vertex in the t-chart. Refer back to it if the topic comes up.

Polygon Chart

Name:_____

Definition of a polygon:_____

Examples of Polygons	Examples that ARE NOT Polygons
	

- **Cereal Boxes**

Cereal Boxes

Kelly and Anthony were looking at the cereal box at breakfast. Kelly told Anthony that the box was made of one plane figure. Anthony argued that the box was made of more than one plane figure.

Look at your cereal box to help you figure out which child is correct.
Use pictures, words, and numbers to explain your answer.

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Discussion, Suggestions, Possible Solutions

Possible solutions will include pictures or diagrams of a rectangular prism. Students may argue that the box is made of one plane figure – the rectangle – but that they are of different sizes. Others may argue that the box is made of three plane figures because there are 3 different sized rectangles incorporated in the cereal box. Allow students to cut apart the box if necessary.

Students who have a strong understanding of prisms may extend the activity by using a different type of prism as an example to prove that different types of prisms could be made of different plane figures. For example, a triangular prism is made of triangles and quadrilaterals.

- **3-D Detective**

3-D Detective

Peek at the geometric figure in the container. Don't let your partner see!
Write down as many of your figure's attributes as you can. For example number of edges, vertices, and angles.
You can look back at the figure as many times as necessary.
When you and your partner are both finished writing your descriptions, take turns reading your descriptions to each other. Try to guess what figure your partner has and draw it on your paper!
Let your partner check your guess and drawing.

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Discussion, Suggestions, Possible Solutions

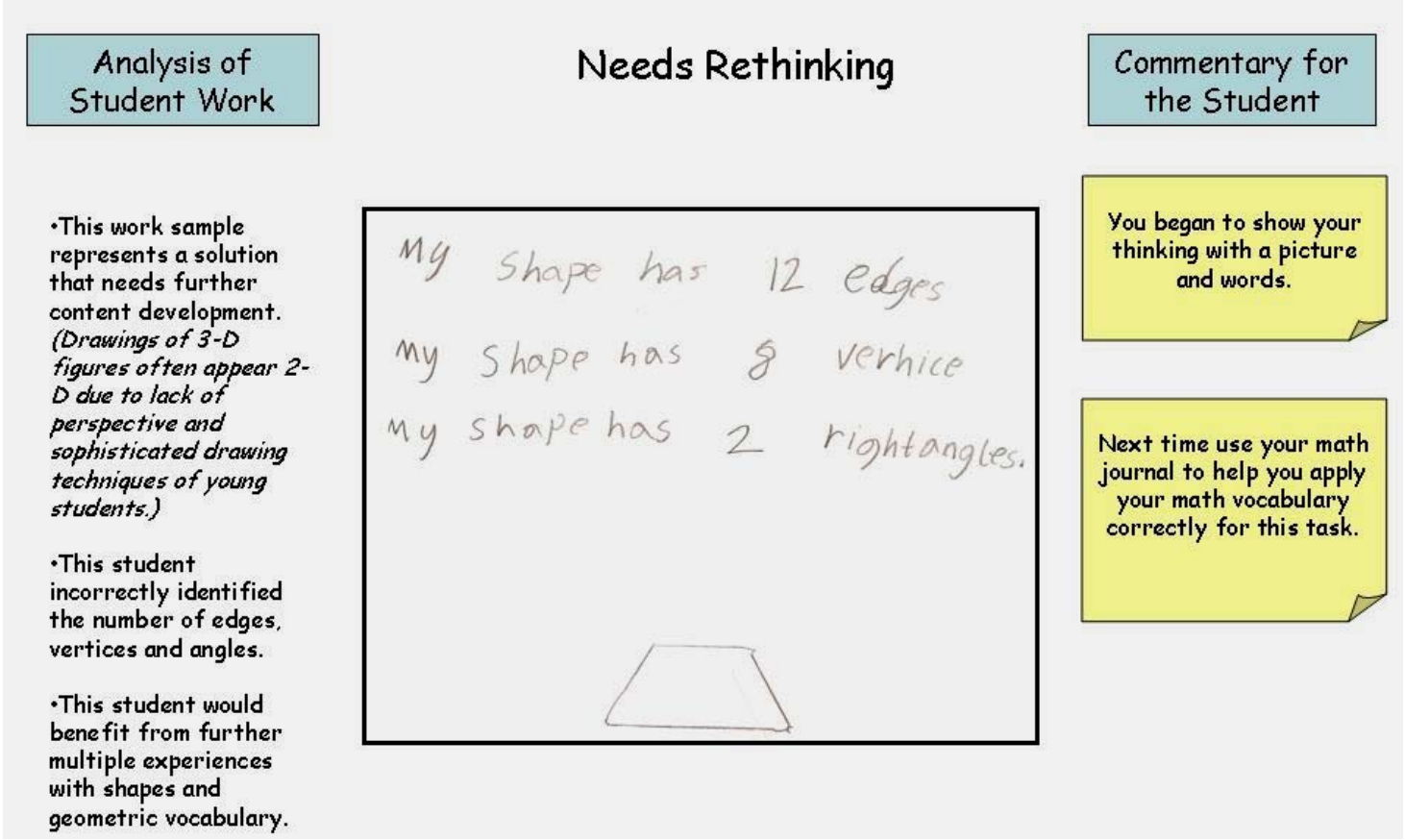
- *Each student will have a solid figure in an envelope or bag.*
- *The students are told to examine their block (or figure) without showing others and describe it by the attributes of edges, vertices and angles.*
- *They are to write these descriptions on paper.*
- *They can then read their descriptions to a partner and the partner tries to guess the solid figure.*
- *As a summary, a student with each figure could share with the entire class.*

Students' written descriptions and drawings will reflect levels of understanding. Keep in mind that drawing three-dimensional figures is extremely challenging to 2nd grade students. It is common for students to miscount faces, edges, and vertices if they do not have a systematic method of counting without skipping parts or counting parts more than once, so be sure to model counting the parts of a space figure when introducing and exploring space figures.

Extension:

In this interactive geometry investigation students will explore geometric solids and their properties.
http://illuminations.nctm.org/LessonDetail.aspx?ID=L407

Samples of Georgia student work are shown below.



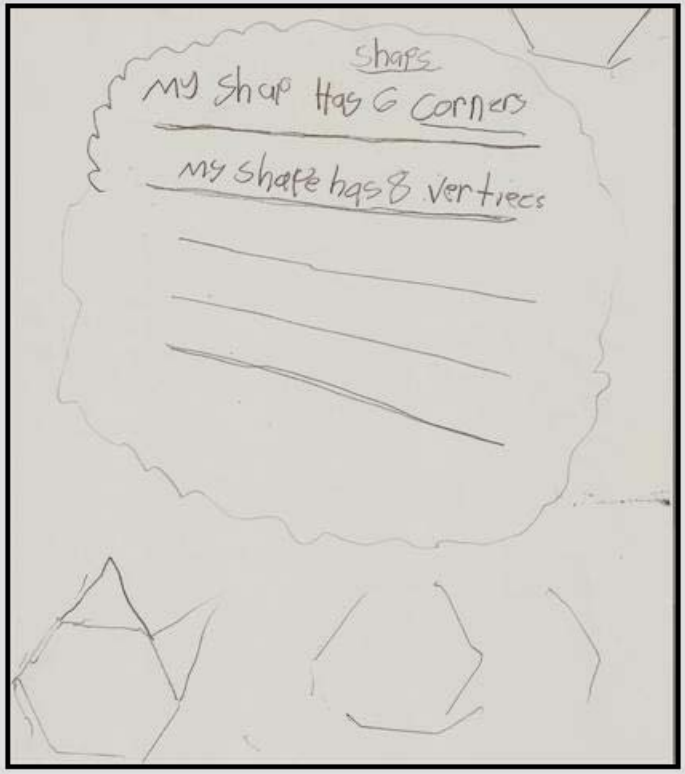
Analysis of Student Work

•This work sample represents a solution that needs further content development.
•*(Drawings of 3-D figures often appear 2-D due to lack of perspective and sophisticated drawing techniques of young students.)*

•While the student correctly identified his shape had six corners, he incorrectly identified the number of vertices.

•This student would benefit from further multiple experiences with shapes and geometric vocabulary.

In Development



Commentary for the Student

You began to show your thinking with pictures and words.

You correctly identified that a hexagon has six corners.

Next time use your math journal to help you apply your math vocabulary correctly for this task.

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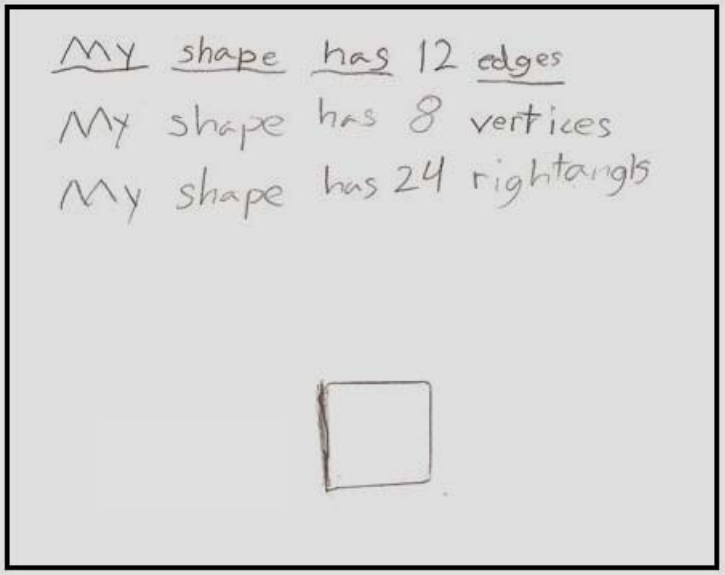
Analysis of Student Work	Quality	Commentary for the Student
•The student represented his thinking with a picture, numbers and words. *(Drawings of 3-D figures often appear 2-D due to lack of perspective and sophisticated drawing techniques of young students.)* •The student correctly identified the number of vertices, edges and right angles. •The student could extend his solution by including additional attributes.		You showed your thinking with a picture, numbers, and words. You included the number of right angles on your cube. Next time extend your solution by including additional attributes.

- **Clay Cones**

Clay Cones

Make 3 clay cones today. Stand them on the bases. (The circular faces)
Make some predictions about what you will see when we cut the cones.
You will cut each cone in a special way: Cut the first cone from the point at one end to the center of the other end. Cut the second cone diagonally across the middle of the cone. Cut the last cone horizontally across the center of the cone.
Draw the results.
Write an explanation of what happens when you cut the cones the 3 different ways.
Were your predictions correct? Why or why not?

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Discussion, Suggestions, Possible Solutions

Model this activity with a different space figure previous to assigning Clay Cones. Allow students to explore taking apart and putting together space figures using clay or any other appropriate and available media.

When asking students to write their predictions, it is important to ask them to picture what they will see when the actual cuts are made. Encourage them to picture what will happen from different viewpoints. Ask questions to prompt their visualization. What will the inside look like when we cut it? What will the face on the bottom look like when we cut it? Be sure to hold up the cone and "pretend" to cut it to assist students in visualizing the outcomes.

After allowing students time to write their predictions, cut the cones and allow ample time to finish the task.

Suggestions: Repeat this activity with as many different geometric solids as time allows. Cut the cones for the students to save time or have them precut so the students just have to pull them apart to check predictions and finish the task.

Possible solutions will include pictures and written descriptions of the cones from various angles. Examples:
There were two circles inside when we cut straight across .
I see two triangles when the cone is cut from top to bottom.
The circle on the bottom is cut in half when we cut from the point to the center of the other end.

- **My Favorite Geometric Solid**

My Favorite Geometric Solid

Write a non-fiction book about your favorite geometric solid.
Your book can be as many pages long as you'd like.
Be sure to use pictures, words, and numbers to describe everything you know about your geometric solid.

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Discussion, Suggestions, Possible Solutions

Previous to assigning the task, review and discuss features of geometric solids found in the real world by reading Cubes, Cones, Cylinders, and Spheres *by Peggy Hoban.*

Possible solutions may include pictures and descriptions of the following: number of edges, number of vertices, number of angles, types of angles, number of faces, geometric names and number of each face, locations and

names of the space figure in the real world (for example a cereal box is a rectangular prism), and cross sections of the figure if it is taken apart and/or put back together again.

Students' written descriptions and drawings will reflect levels of understanding. Keep in mind that drawing three-dimensional figures is extremely challenging to 2nd grade students. It is common for students to miscount faces, edges, and vertices if they do not have a systematic method of counting without skipping parts or counting parts more than once, so be sure to model counting the parts of a space figure when introducing and exploring space figures.

- **Culminating Task**

  This culminating task represents the level of depth, rigor and complexity expected of all second grade students to demonstrate evidence of learning.

Unit Four Task: "MY DREAM HOME/CASTLE"

Work with your group to use as many solid geometric figures as possible to design your dream home or castle. Use pictures, words, and numbers to tell about all of the geometry that you know about the home.

Suggestions for Classroom Use

While this task may serve as a summative assessment, it also may be used for teaching and learning. It is important that all elements of the task be addressed throughout the learning process so that students understand what is expected of them.

- Peer Review
- Display for parent night
- Place in portfolio
- Photographs

Discussion, Suggestions and Possible Solutions

Begin by discussing prior knowledge about what an architect does. Ask if architects use shapes to build things. Are those shapes 3-D or 2-D? Tell students that they are going to work with a team of other architects to design a model of your dream home or castle.

Before you begin this lesson, put children into small cooperative groups. As a group, students will be instructed that they will write down as many geometric solids as they can in 5 minutes. Each student will write the name of only one geometric shape and then pass the paper to the next student. The game ends when the time expires.

Demonstrate how to make cones, rectangular prisms, cylinders, and cubes from photocopied patterns. Have students practice making their own.
Explain to the students that they will be acting as architects and that it is very important for architects to have a plan.
Give students enough time to design a plan for their model dream homes. They must incorporate at least three, 3-dimensional shapes. Encourage the class to do their personal best when "erecting" their structure. Creativity is a positive thing. If students decide to make something else instead of what you asked such as a robot or boat, be flexible!

Mount their creations on tag board, and display them for all to enjoy.

Examples of some questions that could be asked:
1. "What did you learn from this activity? "
2. "What did you like best about it?"

3. "Who can tell me what subject we are studying?"
4. " What do architects do? "
5. " What are three-dimensional shapes?"