Mathematics

Planning Guide

Grade 3

Sorting and Describing Shapes and Objects

Shape and Space
(3-D Objects and 2-D Shapes)

Specific Outcomes 6 and 7

This Planning Guide can be accessed online at:
http://onlineguide.learnalberta.ca/

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Planning Guide: *Grade 3 Sorting and Describing Shapes and Objects*

Strand: Shape and Space (3-D Objects and 2-D Shapes)
Specific Outcomes: 6, 7

This *Planning Guide* addresses the following outcomes from the Program of Studies:

Strand: Shape and Space (3-D Objects and 2-D Shapes)	
Specific Outcomes:	6. Describe 3-D objects according to the shape of the faces and the number of edges and vertices. 7. Sort regular and irregular polygons, including: • triangles • quadrilaterals • pentagons • hexagons • octagons according to the number of sides.

Curriculum Focus

The changes to the curriculum targeted by this sample include:

- The general outcome focuses on characteristics of 3-D objects and 2-D shapes, as well as analyzing relationships between characteristics. This combined emphasis on characteristics and analysis is consistent with the belief that students learn by constructing their own understanding. In this case, students construct their own understanding of geometrical classifications and definitions, rather than learning geometric rules by following set procedures or by rote.
- The specific outcomes for Grade 3 Shape and Space (3-D Objects and 2-D Shapes) are significantly reduced in number. There is now just one outcome that refers to 3-D objects. This outcome echoes the general outcome, with an emphasis on students constructing their own understanding about 3-D objects.
- The only other specific outcome in this section of the Shape and Space strand addresses the study of polygons as a class of shapes. Outcomes focusing specifically on 2-D shapes at Grade 2 and Grade 3 prepare students to meet specific outcomes about 3-D objects.
- Starting around Grade 3, a developmental shift in geometric thinking begins for many students. Rather than simply recognizing and naming shapes based on the way they look, students begin to recognize common characteristics of a group of shapes, and are able to analyze and describe shapes based on those characteristics. Some Grade 3 students learn to generalize about shapes, naming shapes based on abstract definitions rather than visual

impressions. The specific outcomes for Shape and Space (3-D and 2-D objects) at the Grade 3 level in the revised Program of Studies support students who are beginning to analyze and generalize about the characteristics of shapes. At the same time, students who are not yet ready for this have the opportunity to build their experience with shapes, a necessary prerequisite for the development of geometric thinking in future years.

What Is a Planning Guide?

Planning Guides are a tool for teachers to use in designing instruction and assessment that focuses on developing and deepening students' understanding of mathematical concepts. This tool is based on the process outlined in *Understanding by Design* by Grant Wiggins and Jay McTighe.

Planning Steps

The following steps will help you through the Planning Guide:

Step 1: Identify Outcomes to Address

Guiding Questions

- What do I want my students to learn?
- What can my students currently understand and do?
- What do I want my students to understand and be able to do based on the Big Ideas and specific outcomes in the program of studies?

Big Ideas

- 3-D objects and 2-D shapes can be analyzed according to their attributes.
- 3-D objects and 2-D shapes with similar attributes can be grouped together into classes of shapes.
- 3-D objects can be analyzed, grouped and defined based on the number and shape of faces and the number of edges and vertices.
- There are relationships between the number and shape of the faces of a 3-D object, and the number of its edges and vertices.
- By thinking about the particular attributes of a class of 2-D shapes and the relationships between those attributes, students begin to generalize about shapes, assign shapes to particular classes and construct definitions of classes of shapes.
- There are mathematical conventions that govern how 2-D shapes are classified and named. One important attribute by which 2-D shapes are classified is the number of sides.

Sequence of Outcomes from the Program of Studies

See http://education.alberta.ca/teachers/program/math/educator/progstudy.aspx for the complete program of studies.

Grade 2	Grade 3	Grade 4
Specific Outcomes	**Specific Outcomes**	**Specific Outcomes**
6. Sort 2-D shapes and 3-D objects, using two attributes, and explain the sorting rule. 7. Describe, compare and construct 3-D objects, including: • cubes • spheres • cones • cylinders • pyramids. 8. Describe, compare and construct 2-D shapes, including: • triangles • squares • rectangles • circles. 9. Identify 2-D shapes as parts of 3-D objects in the environment.	6. Describe 3-D objects according to the shape of the faces and the number of edges and vertices. 7. Sort regular and irregular polygons, including: • triangles • quadrilaterals • pentagons • hexagons • octagons according to the number of sides.	4. Describe and construct right rectangular and right triangular prisms.

Step 2: Determine Evidence of Student Learning

Guiding Questions

- What evidence will I look for to know that learning has occurred?
- What should students demonstrate to show their understanding of the mathematical concepts, skills and Big Ideas?

Using Achievement Indicators

As you begin planning lessons and learning activities, keep in mind ongoing ways to monitor and assess student learning. One starting point for this planning is to consider the achievement indicators listed in the *Mathematics Kindergarten to Grade 9 Program of Studies with Achievement Indicators*. You may also generate your own indicators and use them to guide your observation of students.

The following indicators may be used to determine whether or not students have met this specific outcome. Can students:

- identify the faces, edges and vertices of given 3-D objects, including cubes, spheres, cones, cylinders, pyramids and prisms?
- identify the shape of the faces of a given 3-D object?
- determine the number of faces, edges and vertices of a given 3-D object?
- construct a skeleton of a given 3-D object, and describe how the skeleton relates to the 3-D object?
- sort a given set of 3-D objects according to the number of faces, edges or vertices?
- classify a given set of regular and irregular polygons according to the number of sides?
- identify given regular and irregular polygons that have different dimensions?
- identify given regular and irregular polygons that have different orientations?

Sample behaviours to look for related to these indicators are suggested for some of the activities listed in **Step 3, Section C: Choosing Learning Activities** (p. 11).

Step 3: Plan for Instruction

Guiding Questions

- What learning opportunities and experiences should I provide to promote learning of the outcomes and permit students to demonstrate their learning?
- What teaching strategies and resources should I use?
- How will I meet the diverse learning needs of my students?

A. Assessing Prior Knowledge and Skills

Before introducing new material, consider ways to assess and build on students' knowledge and skills related to 2-D shapes and 3-D objects. For example:

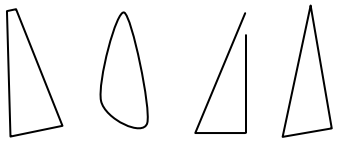
- How many different kinds of triangles can students draw? Have students write or discuss orally what is different about each triangle.
- How many different kinds of four-sided shapes can students draw? Have pairs of students compare their results. Which shapes could be considered part of the same group, and why?
- After the teacher makes a shape using a large geoboard template or clear geoboard on the overhead, have students use geoboards to make a shape that has something in common and not in common with the teacher's shape, and discuss.
- Using sets of geometric objects, or one set of objects used by the teacher and modelling clay for each student, have students choose or make an object that has something in common and not in common with the teacher's object, and discuss.
- Using cards that show the shapes of the faces of geometric objects, and a set of geometric objects, have students select cards that represent one of the faces of a given 3-D object. Sample face cards can be found online at http://illuminations.nctm.org/lessons/iveseen/SeenShape-AS-FaceCards.pdf.

Rather than look for preconceived right or wrong responses to these tasks, teachers should listen to their students' reasoning about why an object or shape is the same or different compared to another object or shape. Do students answer in a way that shows thoughtful analysis of attributes such as sides, faces, vertices and edges? Are students beginning to think in terms of classes of shapes or objects, generalizing about attributes that are the same or different? Are students beginning to form definitions for particular kinds of shapes based on attributes such as equal sides, regular angles or lines of symmetry, even if they do not have the mathematical language to produce conventional labels?

If a student appears to have difficulty with these tasks, consider further individual assessment, such as a structured interview, to determine the student's level of skill and understanding. See **Sample Structured Interview: Assessing Prior Knowledge and Skills** (p. 8).

Sample Structured Interview: Assessing Prior Knowledge and Skills

Directions	Date:	
	Not Quite There	**Ready to Apply**
To check if a student has a basic understanding of shapes based on visual recognition: Use a set of shapes (or paper cut outs) that includes at least one circle, square and rectangle, as well as a selection of triangles; e.g., equilateral, isosceles, scalene, right, obtuse, acute. Say, "**Please sort these shapes and explain your sorting rule." (Be careful not to name shapes for the student.)**	Cannot sort shapes according to common characteristics. Cannot articulate a sorting rule. Does not focus sorting rule on geometric attributes such as curves, sides or angles.	Is able to sort shapes according to common characteristics. Is able to articulate a sorting rule. Focuses on geometric attributes such as curves, sides or angles when inventing a sorting rule.
To check if a student has basic knowledge of common shape names: Use a set of shapes (or paper cut outs) that includes a circle, square, rectangle and a selection of triangles; e.g., equilateral, isosceles, scalene. Note that it is not necessary to ask a student to name a shape if the student already named the shape in the previous task. Say, "**Please tell me the names of these shapes."**	Does not know the names of common shapes. Does not recognize that there are different kinds of triangles. Calls some triangles by the wrong name, or responds with "I don't know."	Knows the names of common shapes. When presented with different kinds of triangles, identifies all as triangles.

To see if a student is able to apply or articulate a definition for a shape: Show the student a strip of paper with the following four shapes on it.  Say, "**Please show me which of these shapes is a triangle.**" After student responds to the above request, say, "**Please explain why this shape is a triangle (or these shapes are triangles).**"	Identifies all shapes as triangles. Knows that not all the shapes are triangles, but cannot explain why any given shape might not be a triangle.	May identify more than one shape as a triangle, and is able to explain why some of the other shapes are not triangles; e.g., one has a corner cut off, one has rounded corners and one is not closed. Identifies only the fourth shape as a triangle. Clearly identifies which shape is a triangle, and provides a definition to support the choice.
To see if a student will be able to describe 3-D objects based on observations about faces, edges and vertices: Place a collection of geometric solids on the table between you and the student. Pick one up and touch a face (or edge, or vertex). Say, "**This is a face (edge/ vertex). Can you find and show me a face (edge/vertex) of one of the other objects on the table?"** Repeat twice for each attribute.	Is unable to identify one of the attributes on a self-selected object. Inconsistently identifies any of the attributes on a self-selected object.	Consistently identifies the attributes face, edge and vertex on 3-D objects.

B. Choosing Instructional Strategies

Consider the following guidelines for teaching 2-D shapes and 3-D objects in Grade 3:

- Use an "Assessment for Learning" approach to ensure that students understand the learning intentions for all activities, understand what distinguishes quality work, receive descriptive feedback about their progress and have opportunities for self- and peer-assessment. For example, use the "Traffic Lights for 3-D Objects" and "Traffic Lights for 2-D Shapes" (Appendix 1, p. 31) before and after self-assessment of learning.
- Immediately after presenting a task, have students discuss the task with a partner and make predictions as to the outcome of the task.
- Have students work in partners or groups of three or four to complete tasks.
- Invite students to reflect on their predictions after a task has been completed.
- Ensure that students experience shapes and objects in different sizes and orientations. Shapes and objects that can be manipulated are a better choice for tasks than shapes that are printed on a page. Use paper shapes, clay solids, constructed solids, geometric solids, pattern blocks, tangrams, pentominoes, geoboards, attribute blocks, tessellation tiles, as well as virtual manipulatives (Internet or software programs) that can be moved around. A recommended source for virtual manipulatives is online at the National Library of Virtual Manipulatives site at http://nlvm.usu.edu/en/NAV/topic_t_3.html. Ensure that shapes include convex and concave angles, irregular polygons and a variety of quadrilaterals such as trapezoids and parallelograms. Ensure that students experience irregular 3-D objects.
- Plan a significant amount of time for students to compare strategies and outcomes as a whole class after a task has been completed. During this time, ask questions about the efficiency and mathematical thinking of particular responses to encourage greater abstraction and mathematical elegance.
- Ensure that tasks are differentiated. Students who are able to generalize about shapes and objects should have the opportunity to do so in the context of a given task and in response to questioning from the teacher. Students who rely on visual similarities between shapes and objects to complete tasks should be encouraged to do so, formulating correct responses based on visual observations rather than abstract generalizations. Both types of response are acceptable and correct at the Grade 3 level.
- Develop mathematical language for geometric shapes and objects and their properties. Many classroom communities like to adopt invented terms as common classroom language and appreciate it when the teacher honours these terms. It is also important, however, to introduce terms used by the wider mathematical community as appropriate language to use outside the context of the classroom; e.g., "The shape that we call a Bruce-angle is called a rhombus by most mathematicians." Students can look up terms and explore virtual shapes and objects using, for example, LearnAlberta's online mathematics glossary at http://www.learnalberta.ca/content/memg/index.html. The glossary has interactive demonstration applets for different kinds of polygons and clearly illustrated definitions for the terms edge, vertex and face. This can be a warm-up activity at the beginning of a lesson

based in the computer lab. For example, use it as a part of Sample Learning Activity 3: Tangrams (p. 16), if you are using the virtual tangrams found at the National Library of Virtual Manipulatives site at http://nlvm.usu.edu/en/NAV/frames_asid_268_g_1_t_3.html?open=activities&from=topic_t_3.html. During any of the sample activities, learners can relate conventional and invented terms by making charts, posters or a class dictionary to create a common reference.

- Consider teaching geometry throughout the year, rather than as a discrete unit. For example, do one sample learning activity each month. Briefly review ideas already developed, using the work students produced previously, to trigger prior knowledge the next time a geometry activity is introduced.

C. Choosing Learning Activities

The following learning activities are examples of activities that could be used to develop student understanding of the concepts identified in Step 1.

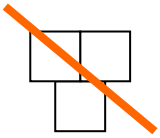
Sample Activities:

1. **Pentominoes** (p. 12)
2. **How Many Shapes?** (p. 14)
3. **Tangrams** (p. 16)
4. **Different Types of Polygons** (p. 17)
5. **Solid Objects and Face Cards** (p. 18)
6. **3-D Object Skeletons** (p. 19)
7. **Large 3-D Skeletons** (p. 20)

Sample Activity 1: Pentominoes

Draw on prior knowledge by asking students to volunteer names of shapes that they already know. Choose students to come up to the overhead and share a few examples. Hand out 2 cm square tiles while completing this activity.

As a warm-up activity, have students make shapes with exactly three tiles. Shapes made with three tiles are called Triominoes. To make triominoes, the tiles need to touch so that the side of one tile matches exactly with the side of the tile it is touching.



(Not acceptable)

How many different triominoes are there? Students can draw their answers on the overhead or board. Are there some answers that look different but are actually the same shape? In fact there are only two triomino shapes:

Look For …

Do students:

- ☐ correctly follow the instructions in the task?
- ☐ make just one example of each shape, regardless of orientation?
- ☐ analyze the shapes to make sure they have found them all?
- ☐ explain their thinking about whether they have found all the shapes?
- ☐ explain their thinking about their own or another student's sorting rule?

Now, students will work with one or two other students to make pentominoes. Pentominoes are made from five squares. Their task is to make all the different types of pentominoes. Once they have made these with tiles, students can transfer their designs onto coloured 2 cm grid paper and cut them out. There are 12 possibilities. The teacher will need to decide whether or not (or when) to share this information.

While students are working, the teacher circulates and reminds students of the rules and task, if necessary. If a group has made more than one example of the same shape, the teacher can say, "I notice that two of the shapes you have made are actually the same shape—can you figure out which two?" If a group has correctly found all 12 shapes, ask "How do you know if you have all the possibilities?" Students who can answer this question can make tetrominoes (shapes made from four squares) and answer the question about how many different tetrominoes there are. (There are five.)

Once most pairs have found all the pentominoes, they can have students come up one-by-one to share a new shape by attaching it to the board (or wall or chart in a sharing area) using magnets or "sticky-tac." This is done until the class is satisfied that they have one example of each of the possible shapes. How do students know they have found all the shapes? Is there a way to analyze the shapes to be sure?

Finally, how could you sort these shapes? Many students like to name them, often after letters of the alphabet. Have two or three students come up to the board and sort the pentominoes according to a rule, and have other students guess the rule. If no student uses the rule "number of sides the same" then the teacher can do a sort using this rule to bring attention to it. The teacher should highlight this sorting rule as one that is used to sort shapes that have straight sides. Introduce the term "polygon" and define it as a closed shape made up of line segments.

Sample Activity 2: How Many Shapes?

This activity is adapted from Lynae Sakshaug, Milfried Olson and Judith Olson, *Children Are Mathematical Problem Solvers* (p. 58). Copyright © 2002 by the National Council of Teachers of Mathematics. Reprinted by permission of the publisher.

Draw on prior knowledge by reminding students about what they discovered when they made shapes from square tiles. Ask students to predict, with a partner, what kind of shapes they could make from triangles. Make a list of their ideas.

Hand out paper squares to students at random so that four students have 5 cm squares that are one colour, another four have 6 cm squares that are a different colour, another four have 7 cm squares that are a different colour, another four have 8 cm squares that are a different colour, and so on until everyone has squares. Colours can be repeated, as long as squares that are close to the same size are different colours. Have plenty of extra squares available.

Show students how to fold squares carefully on the diagonal to make two triangles and have them cut along the line to make two triangles from each square.

As a warm-up activity, ask how many shapes can be made from just two triangles. The rules for making a shape are that pieces need to touch, matching edge-to-edge, and edges need to be the same length. Share answers (three shapes). Do any of these shapes have names that students already know?

Then have students find a partner who has the same size and colour triangles, and have partners work together to find out how many shapes they can make from three triangles. They can make more triangles, as necessary. As a class, agree on these shapes (there are four) and post examples or draw them on the board.

Look For …

Do students:

- ☐ correctly follow the instructions in the task?
- ☐ work systematically, building on or varying shapes they have already discovered?
- ☐ analyze the shapes to make sure they have found them all?
- ☐ analyze the shapes to make sure they have not found two shapes the same?
- ☐ explain their thinking about whether they have found all the shapes?
- ☐ explain their thinking about their own or another student's sorting rule?

Now have each partnership find another partnership with the same size and colour triangles to form a group of four. Their task is to find all the shapes that can be made from four triangles, according to the rule that edges that touch have to be the same length and fit together corner-to-corner. How many shapes do they predict they can make? (They may base this prediction on their work with pentominoes, or on the number of shapes they made from two or three triangles.) There are 14 possible shapes, but students do not need to be told how many to complete this task successfully.

While students are working, the teacher can circulate and discuss what students are discovering, challenge them to think in different ways or point out that they may have some shapes that are actually the same. The teacher may ask students how they know they have found all the possible shapes. There will be opportunities to introduce mathematical language, especially the names of new shapes like parallelograms and trapezoids, and words describing shapes that are the same, like congruent, rotated or flipped (reflected). This may also be an opportune moment to discuss the concept of concave and convex shapes.

Once students have found all the shapes they can, they will get a large piece of paper for gluing the shapes down. Before they glue anything down, they should sort the shapes according to a sorting rule and arrange them neatly on the paper to make a chart. Some students will need a larger piece of paper, or two pieces of large paper, if they are working with larger shapes. They will write their sorting rule down on the chart in an appropriate place, and label each section of the chart appropriately.

When posters are shared in the whole group session at the end of the class, the teacher will look for sorting rules based on number of sides, and whether all sides are convex or some sides are concave. If these examples do not exist, the teacher can show them to the class using some spare triangles (or by drawing some shapes on the board), and ask students to guess the sorting rule. The idea of concave or convex shapes will be introduced to students, along with either invented or conventional language for these types of shapes.

Another idea that should be discussed with the whole group in the context of this activity is whether different size and orientation of shapes make a difference for how they are classified. Did students with smaller triangles find the same shapes as students with larger triangles? If there are posters with the same shape in a different orientation, the teacher can challenge the class to find the two that are the same.

Sample Activity 3: Tangrams

Hand out sets of tangrams or use virtual tangrams. Ask students to work with a partner to predict, without touching the tangrams, what types of polygons they can make using two or more tangram pieces.

As a warm-up activity, have students work with their partner to find all the different ways to make triangles. Challenge students to make a triangle with one, two, three, five and seven pieces.

Now students can work in small groups to figure out ways to make other polygons with the tangram pieces. What different polygons can be made? How many pieces does it take to make each polygon? Are there other similar polygons (same shape, different size) besides triangles that can be made with different numbers of pieces? What different polygons can be made that have no concave sides? Is it more difficult to find convex polygons or concave ones? Do they notice other things about the polygons they have made; e.g., things that are the same or different in a given shape (regularity or irregularity, repeated size of some angles or sides)?

Have students draw and cut out the shapes they make (drawing in the outlines of the tangram pieces so others can see how they made the shapes). They can write the number of tangram pieces used to make a shape in the middle of the shape. Hand out large pieces of coloured paper and have students organize their discoveries onto a chart. The students should organize their shapes on the chart in a way that shows similarities and differences between the shapes.

Look For …

Do students:

- ☐ use appropriate language to talk about shapes?
- ☐ sort shapes based on the number of sides?
- ☐ sort polygons in other relevant ways?
- ☐ create an organizational strategy that communicates an understanding of different types of polygons?
- ☐ explain their discoveries and understandings to their peers?

Share and discuss the work with the whole group. Encourage students to use names for the different polygons and to explain why they organized their chart in the way they did.

Fast finishers can find different ways to make squares. Students can try to make a square with one, two, three, four, five, six or all seven tangram pieces. Which one of these squares is not possible? Can they explain why it is impossible?

Sample Activity 4: Different Types of Polygons

Draw on prior knowledge by reviewing student work from activities like Sample Activity 1: Pentominoes, Sample Activity 2: How Many Shapes? and Sample Activity 3: Tangrams. Post the work done as part of these activities so that students can use it as a reference to complete the following task.

Review concepts and any terminology already introduced or invented for different kinds of polygons, regular and irregular shapes, and convex and concave shapes.

As a class, discuss whether or not, and why, you are going to use conventional names or invented names to refer to polygons (conventional terms because they communicate to a wider audience or invented terms because they are personally relevant and easier to understand within the classroom community). As an optional warm-up activity, hand out sticky notes and have each student label one or more of the polygons that exist on the posters around the room. Discuss these names, and differentiate between names for classes of polygons, and names for sub-types within a class.

At some later point during this activity, you may want to discuss with groups or with the class if you are going to use names for sub-types of polygons, or just identify rules that can be used to classify sub-types. Conventional names for different triangles and quadrilaterals are in common usage, but not names for sub-types of other polygons. It may be most appropriate at Grade 3 to use made-up names for sub-types of all polygons.

Divide the class into at least five groups. Assign one class of polygon to each group. There will be at least one group for each of triangles, quadrilaterals, pentagons, hexagons and octagons. The task is to figure out and draw as many different types of polygons as possible of whichever type has been assigned to that group. Each group will make a large poster depicting all these different types of one class of polygon. Groups should use materials such as geoboards, large grid paper, isometric dot paper, various types of tiles, pattern blocks and the posters around the room to come up with different shapes to draw, cut out and glue to their poster and label with rules or names. Students should only put one example of each different sub-type of shape on their poster.

While students are working the teacher can circulate and challenge students to discuss if sets or pairs of shapes are the same or different, and why.

Bring the class together to share the work in the large group by talking about the shapes chosen and the rules used. Students can bring grid and dot paper and geoboards to the meeting. Challenge students to suggest sub-types that are not on the posters, and discuss whether they are different or the same. Have students justify why they made the decisions they did on their posters.

Posters can be on display around the classroom for a period of time so that students can add additional shapes, if justified.

Sample Activity 5: Solid Objects and Face Cards

This activity is adapted from John A. Van de Walle and Sandra Folk, *Elementary and Middle School Mathematics: Teaching Developmentally* (p. 334). Copyright © 2005 by Pearson Education Canada Inc. Reprinted by permission of the publisher.

Look For …

Do students:

- ☐ show an understanding of the definitions of face, edge and vertex?
- ☐ create objects according to the supplied criteria?
- ☐ show flexibility in accepting or creating more than one way to meet the criteria?
- ☐ present a correct solution to the problem?
- ☐ present a solution to the problem in a way that makes it easily understood by other students?

To help students access prior knowledge, use large geometric solids or project pictures of solids onto a screen and have students make observations about the objects. Do they recognize any of the shapes that make up the objects? Does the picture remind them of anything they know? How many different things does it remind them of?

As a warm-up activity, hand out modelling clay. Hold up a geometric solid and ask students to make, as quickly as they can, an object that looks the same and then to hold up the object. Do this for three or four objects.

Use large examples of face cards, by enlarging small face cards such as those that can be found online at http://illuminations.nctm.org/lessons/iveseen/SeenShape-AS-FaceCards.pdf, or by drawing shapes on cards such as different types of rectangles (including a square), triangles or simple polygons. Hold up a card and ask students to use their modelling clay to make an object that has one or more of its faces that match the shape on the card. Challenge students who finish quickly to make a different object that fits the criteria. Can students make an object that has all its faces match the shape on the card? Repeat this activity for different shapes and have students observe the different shapes being made.

Pose the following problem to students: using small sample face cards, if necessary, make an object that you can show to the whole class and make a set of face cards that match all the faces on the object. Alternatively, students can draw all the faces on one piece of paper. Circulate among the students, challenging them to explain their work to you and to name the shape of each of the faces of their object. Students can number the faces on their object and write corresponding numbers on the face cards if this helps.

Gather as a class to share some of the students' work. If the group shows an appropriate level of understanding, have students show just their object and challenge others to guess what face cards they made, or have students show just their face cards and challenge others to guess or model what object they made with additional modelling clay.

As an extension, repeat the above activities using numbers of edges or vertices instead of face cards. Have students make objects, determine number of edges or vertices, hide the object, tell the number and features to the class and see what others made.

Can students make objects with zero edges? Two edges? More? With one vertex?

Sample Activity 6: 3-D Object Skeletons

Draw on prior knowledge by having students take turns telling a partner what they learned in Sample Activity 5.

As a warm-up activity, play "What object am I?" using clues like:

- all my faces are rectangles
- two of my faces are triangles
- one of my faces is a square and the rest are triangles
- all my faces are squares.

Rather than have students name objects, you can have them point out geometric solids, hold up solids or pictures of solids, or make objects that fit the description using modelling clay.

For the following activity, students will need toothpicks and/or wooden skewers cut in three distinct lengths (e.g., 4 cm, 8 cm, 12 cm) and modelling clay to make skeletons of 3-D objects. Students can practise making little peas from the modelling clay to join the sticks together to make a cube from the smallest sticks. Ideally, students will have a solid cube of this size as a reference for their skeleton.

Pose the following problem to the class: how many different types of objects can we represent using these materials? Have students make objects and bring them up to a table or ledge. They can only leave their object on the table if it is different in some way from all objects that are already there. For example, a cube made from the smaller sticks would be different from a cube made from the larger sticks. Have students continue to make different objects until there are enough for every student to have one object. Challenge students to make irregular or unusual objects.

Distribute the objects to students. Explain to students that in an object skeleton, the sticks are the same as edges and the clay "peas" are the same as vertices. Ask students to move around until they find a partner who has an object with the same number of edges as their object and to verify this by counting each other's edges. Ask them to find a different partner who has an object with the same number of vertices. Does anyone have trouble finding a partner? Can anyone think of a way to make an object that would match that person's object?

As an extension activity make a floor graph or chart of the objects based on number of edges, number of vertices, or both.

Sample Activity 7: Large 3-D Skeletons

In this activity, students build large skeletons of 3-D objects using rolled up sheets of newspaper. Draw on prior knowledge by having partners take turns to explain to each other what a face is, what an edge is and what a vertex is. Share observations and discoveries from previous activities about 3-D objects.

As a warm-up activity, have partners work together to build two small objects quickly, using the modelling clay peas and toothpicks from Sample Activity 6. One of the constructed objects should have some or all its faces in the shape of triangles. The other object should have no triangular faces. Students should then test the objects for structural strength at different orientations. Partners should come to a conclusion about what makes an object stronger and be prepared to share the conclusion with the class.

Distribute newspaper for making rods and have plenty of masking tape available for attaching rods together. In some cases, staplers will also be helpful. Have students practise making a rod from three pieces of newspaper, rolled as tightly as possible on the diagonal, and secured at the centre with a small piece of tape. Discuss the possibility of different lengths of rods, and ask students to think about what the implications might be for a structure they were trying to build by joining objects together if the edges or faces of the objects were different sizes.

Put students into groups of four or five and have them build a composite structure by making object skeletons from newspaper rods and then joining objects together by matching edges and faces. It is possible that there will be a practical reason to build large structures using newspaper rods; for example, as a Kindergarten buddy activity or as the building of an archway, tunnel or structure for a haunted house or carnival. If this is the case, you may want to work with students on a plan for groups to create discrete parts of the overall structure.

Encourage small group discussion about shapes of faces and numbers of edges and vertices when joining objects, as well as structural strength, as students plan and work on their structure together. Prompt them to tell you how many objects they used to make their structure and how the objects fit together.

When students share their structures with the large group, they should be prepared to identify the composite objects for the rest of the class by pointing out faces, edges and vertices.

Step 4: Assess Student Learning

Guiding Questions

- Look back at what you determined as acceptable evidence in Step 2.
- What are the most appropriate methods and activities for assessing student learning?
- How will I align my assessment strategies with my teaching strategies?

In addition to ongoing assessment throughout the lessons, consider the following sample activities to evaluate students' learning at key milestones. Suggestions are given for assessing all students as a class or in groups, individual students in need of further evaluation, and individual or groups of students in a variety of contexts.

A. Whole Class/Group Assessment

Geometric Shapes and Objects Card Games

In this performance assessment task, students will demonstrate their understanding of polygons and 3-D objects. Students will make and play card games to show that they can sort polygons according to the number of sides, and describe 3-D objects according to the shape of the faces and the number of edges and vertices.

Materials required: pencils, paper, 20–30 small pre-cut cards per student, 3-D object stamps or photocopied pictures of objects (optional, as necessary).

Distribute the task sheet and rubric. Discuss the task and expectations with students. Have students form partnerships and decide on roles. Help students to highlight the parts on their task sheet that refer to just their work and cross out the part of their task that refers to their partner's work. Distribute materials and ensure students have sufficient class time to discuss their game and make some or all of the materials in class.

If students are having trouble getting started, have them choose a game they already know, and challenge them to find a way to change the cards for that game so that players either have to sort polygons or describe 3-D objects, depending on which is their task. The 3-D partners can use pictures of objects, as well as pictures of all object faces, pictures of one or some object faces, and/or numbers (to match to vertices and edges) on their cards. As students are making their games, challenge them by asking them to explain how their game will test the learning objective they have chosen to test.

Once all the materials are made, ensure students have time to practise their game with their partner before their performance assessment.

When all students are ready, assess the task. Parents or volunteers can help with the assessment by being the older person to whom students present their games. If you are using helpers, go over the performance checklist in advance to make sure they know what they are looking for from each student. Ideally, the teacher will not have a group to work with and will be able to circulate.

If a student is not able to show his or her understanding because the game the partner made does not adequately test his or her skills, have the student work with another group for this part of the assessment, or have extra copies available of both types of game that you or another student has prepared.

At a later time, the teacher can use the information from the checklist and information gained by circulating between groups, as well as the sets of cards and rules that students have produced, to assess each student using the performance task rubric.

Students who finish their performance assessment before the whole class is done may teach and play their games with other students who are also finished.

Name: _____

STUDENT ASSESSMENT TASK
Geometric Shapes and Objects Card Games

Work with a partner. Choose one person (partner polygon) to make a polygons card game and one person (partner 3-D) to make a 3-D object card game.

- Your games can be based on existing card games such as memory, go fish, rummy or war, or another game you know or make up.
- If you are making a polygon card game, the game must test whether the players can sort polygons based on the number of sides.
- If you are making the 3-D objects card game, the game must test whether the players can describe 3-D objects according to the shapes of the faces and the number of vertices and edges.

Each student will:

1. Make a deck between 20 and 30 cards of either 3-D objects or 2-D shapes, showing many different examples of objects or shapes.
2. Write up the rules for the game with the partner's help.
3. Test out the game with the partner's help.
4. Explain the game to an older person who will watch students play it and decide if the game really does test the concepts learned, and if the players learned these concepts.

Name: _____

SCORING GUIDE
Geometric Shapes and Objects Card Games

Level / Criteria	4 Excellent	3 Proficient	2 Adequate	1 Limited	Insufficient / Blank
My Cards	Student made at least 20 cards that showed a variety of different examples of all five types of polygons studied or a selection of at least four types of objects, with no duplicates. ☐	Student made at least 20 cards that showed different examples of all five types of polygons studied or a selection of at least four types of objects. ☐	Student made at least 10 cards that showed at least two examples of some of the types of polygons or 3-D objects studied. ☐	Student made less than 10 cards that showed at least three different types of polygons or 3-D objects. ☐	Student made less than five cards. Student's cards did not show different kinds of polygons or 3-D objects. ☐
My Game Rules	Student made up a game and clearly communicated the rules and objectives orally and in writing. Student's game thoroughly tested the learning objective chosen. ☐	Student made up a game and wrote down the rules. Student was able to explain the rules and objectives. Student's game tested the learning objective chosen. ☐	Student made up a game and explained the rules. The game was about the different kinds of polygons or 3-D objects studied. ☐	Student made up a game about polygons or 3-D objects. ☐	Student was not able to show a made-up game. ☐
My Presentation	Student could consistently sort and correctly name polygons according to the number of sides, and that all of the time could correctly describe and name 3-D objects according to the shape of faces and the number of edges and vertices. ☐	Student could sort polygons according to the number of sides and that most of the time could describe 3-D objects according to the shape of faces and the number of edges and vertices. ☐	Student could sort polygons according to the number of sides and that some of the time, with minimal prompting, could describe 3-D objects according to the shape of faces or the number of edges or vertices. ☐	Student needed support to identify different kinds of polygons using either names or number of sides. Student needed support to identify or describe the faces, vertices (corners) or edges of 3-D objects. ☐	Student was not able to sort polygons or describe 3-D objects. ☐

STUDENT ASSESSMENT TASK

Checklist for "Partner Polygon" Card Game

Student Name: _____

Volunteer Name: _____

I watched this student show a game about polygons. The student:

- ✓ made cards that showed many different examples of polygons with different numbers of sides
- ✓ made up a game in which the players had to make pairs or sets of polygons that had the same number of sides
- ✓ explained the game in a way that showed he or she understood how to sort polygons according to the number of sides.

I watched this student play a game about polygons. The student could:

- ✓ identify polygons according to the number of sides
- ✓ sort polygons according to the number of sides
- ✓ use this information to play the game.

STUDENT ASSESSMENT TASK

Checklist for "Partner 3-D" Card Game

Student Name: _____

Volunteer Name: _____

I watched this student show a game about 3-D objects. The student:

- ✓ made cards that showed many different examples of 3-D objects with different shapes of faces, different numbers of edges and different numbers of vertices
- ✓ made up a game in which the players had to use information about the shape of faces, number of edges and number of vertices of 3-D objects
- ✓ explained the game in a way that showed he or she understood how to describe 3-D objects according to the shapes of faces, numbers of edges and numbers of vertices.

I watched this student play a game about 3-D objects. The student could:

- ✓ count the number of vertices (corners) of 3-D objects shown on the cards
- ✓ count the number of edges of 3-D objects shown on the cards
- ✓ describe the shape of the faces of the 3-D objects shown on the cards
- ✓ use this information to play the game.

B. One-on-one Assessment

1. Ask the student to sort a variety of regular and irregular triangles, quadrilaterals, pentagons, hexagons and octagons according to the number of sides.

   Use the following accommodations, if necessary.

   - Reduce the number and variety of polygons.
   - Prompt the student to count the number of sides of the polygons.
     provide moveable numerals to label the sort or encourage the student to make labels based on the number of sides.

2. Ask the student to describe a variety of 3-D objects according to the shape of the faces and the number of vertices and edges. Ask the student to find two objects that have something the same and something different about the shape of their faces or the number of their vertices or edges.

   Use the following accommodations, if necessary.

   - Ask the student to show you an example of a face on an object.
   - Ask the student to show you an example of a vertex on an object.
   - Ask the student to show you an example of an edge on an object.
   - Prompt the student to describe the shape of a face on an object.
   - Prompt the student to count the number of vertices on an object.
   - Prompt the student to count the number of edges on an object.
   - Choose two objects and ask the student to tell you something the same and something different about the shape of some of the faces of the objects.
   - Choose two objects and ask the student to tell you something the same and something different about the number of vertices or edges of the objects.

C. Applied Learning

Provide opportunities for students to describe everyday objects and the world around them in terms of faces, edges, vertices and polygons. For example, on a neighbourhood walk, ask students to identify whether or not the signs they see are true polygons and which polygons they are. Ask students:

- do the shapes have vertices and straight sides?
- how many sides do they have?

OR

Ask students as they observe objects in the school or neighbourhood:

- are the surfaces of the objects actually faces?
- do the objects have edges and vertices?
- what are the shapes of the faces?
- how many vertices are there?
- how many edges are there?

Step 5: Follow-up on Assessment

Guiding Questions

- What conclusions can be made from assessment information?
- How effective have instructional approaches been?
- What are the next steps in instruction?

A. Addressing Gaps in Learning

Students who have difficulty understanding 3-D objects and 2-D shapes will benefit from ongoing structured and unstructured experiences sorting shapes and objects, using shapes to make tiling or tessellating patterns, or building using objects or blocks. Repeated use of geometric language in everyday experiences and tasks involving spatial reasoning will increase students understanding of geometry concepts.

For example:

- Have students work with pattern blocks to build 2-D patterns that follow certain rules; e.g., the blocks cannot be stacked, the table or floor cannot show through anywhere in the pattern, the sides of the pieces have to fit exactly. Model the use of geometric terms by referring to the blocks as triangles, quadrilaterals and hexagons. Specific language for quadrilaterals is not expected in Grade 3; however, squares, trapezoids and rhombuses can be referred to using their proper names, or as the orange, red and blue quadrilaterals. Rhombuses can also be called diamonds. The important feature that students need to recognize is that they have four sides.
- Have students work with tangrams, tiles or pattern blocks and printed outlines (with or without internal lines depending on student ability) to fit shapes into an outline. Increase student motivation by accessing the virtual tangram online at the National Library of Virtual Manipulatives site at http://nlvm.usu.edu/en/NAV/frames_asid_268_g_1_t_3.html?open=activities&from=topic_t_3.html.
- Have students work with geoboards to copy shapes from other geoboards or from prepared cards.
- Gather a group together with a set of wooden blocks. As they play with the blocks, model the use of the terms face, edge and vertex, and encourage students to match faces and count edges and vertices as part of their building. A set of blocks that included pyramids and triangular prisms would be best suited to addressing gaps in student learning about 3-D objects.

B. Reinforcing and Extending Learning

Students who have achieved or exceeded the outcomes will benefit from ongoing opportunities to apply and extend their learning. These activities should support students in developing a deeper understanding of the concept and should not progress to the outcomes in subsequent grades. Consider strategies, such as:

- Provide information for parents about polygons and the features of 3-D shapes. Encourage parents to look for activities that provide students with experience sorting, patterning, tiling and constructing using shapes and objects. Direct parents to virtual manipulatives, such as tessellations, space blocks, pattern blocks, geoboards, isometric geoboards, pentominoes and tangrams, found online at the National Library of Virtual Manipulatives site at http://nlvm.usu.edu/en/NAV/topic_t_3.html, or encourage them to engage in similar activities with their children using paper and pencil or actual manipulatives. The tessellations activity is an excellent extension of activities about polygons.
- Students can use the pentomino shapes they have discovered for a number of games and activities. They can make composite shapes from pentominoes, and then make outlines of their shapes as pentomino puzzles for other students. They can experiment with how many different ways there are to make a 4 x 5 solid rectangle using pentomino pieces. How many pieces are used for each solution? What other sizes of rectangle might be possible? Can they make 5 x 5 or 6 x 5 rectangles? What about 3 x 5? With two sets of pentominoes in different colours, students can take turns placing pieces to fill in portions of a 10 x 10 grid, trying to be the one to place the most pieces. This game can be varied by changing the number of pieces, the size of the grid and the number of players. The commercially available game "Blokus" is a more complex variation of this game.
- Students who seem able to reason about the properties of shapes can make up and exchange shape riddles with each other or with an older person. For example, what shapes can have more than four square corners? What kinds of polygons can you make with three of their sides the same length? What quadrilaterals can you make that have all four sides equal?

Traffic Lights for 3-D Objects

Colour the light

- green for **yes**
- yellow for **maybe**
- red for **no**

Student Name: _____

Before		After
O	I know what a face is on an object.	O
O	I know what an edge is on an object.	O
O	I know what a vertex is on an object.	O
O	I can describe an object by talking about faces, edges and vertices.	O

Traffic Lights for 2-D Shapes

Colour the light

- green for **yes**
- yellow for **maybe**
- red for **no**

Student Name: _____

Before		After
O	I can sort shapes according to the number of sides they have.	O
O	I know what the word polygon means.	O
O	I can sort polygons.	O

Bibliography

Alberta Education. *The Alberta K–9 Mathematics Program of Studies with Achievement Indicators*. Edmonton, AB: Alberta Education, 2007.

Burns, Marilyn. *About Teaching Mathematics: A K–8 Resource.* 2nd ed. Sausalito, CA: Math Solutions Publications, 2000.

Sakshaug, Lynae, Milfried Olson and Judith Olson. *Children Are Mathematical Problem Solvers.* Reston, VA: NCTM, 2002.

Van de Walle, John A. and Sandra Folk. *Elementary and Middle School Mathematics: Teaching Developmentally.* Canadian ed. Toronto, ON: Pearson Education Canada Inc., 2005.