Investigating Shapes

a K-3 multi-lesson exploration

created by teachers in the
BC Reggio-Inspired Mathematics Project
for ShareEDBC
Summer 2020

created and compiled by teachers in the
BC Reggio-Inspired Mathematics Project

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Investigating Shapes – An Overview

Included in this collection are lessons that can be combined to create a focused unit of study or spread over the year to re-visit the concept of shapes.

This collection includes:

- an overview
- Reggio-Inspired principles and practices
- connections to the BC Mathematics Curriculum
- a collection of multi-grade lessons
- lessons include ideas for at-home, online and outdoor learning experiences and connections to grades 4&5 learning standards
- Appendix A: assessment tables
- Appendix B: recommended resources

As students investigate shapes, our goal is not only have students be able to describe, compare or identify the attributes of shapes, but to also be able to make connections between 2D shapes and 3D objects and to think about how shapes are used and viewed in the world around us. Although some students might be curious about the names of shapes, it is important to note that identifying the names of shapes (2D and 3D) is not specifically in the BC learning standards until grades 2 and 3. The focus in Kindergarten and Grade 1 is on describing and comparing the attributes of shapes such as quantity of sides/edges, length of sides (long, short, equal), quantity of vertices/corners, or type of lines (straight, curved). As students describe and compare attributes of shapes, they develop mathematical language and vocabulary and use familiar language and gestures as they make connections to their world. As students begin to use the more specific math language used for geometry, they will be able to use that language and their understanding of shapes to generalize identity properties of shapes and answer questions such as: What makes a rectangle a rectangle?

Spatial reasoning is an area of mathematics which is currently being focused on in education research. Spatial reasoning is based in dynamic processes with a focus on mental understanding and physical transformation. Canadian

researchers (Moss, Bruce et al, 2016) have identified five key aspects of spatial reasoning: 1) symmetry, 2) transforming, 3) composing and decomposing 2D images and 3D objects, 4) locating, orienting, mapping and coding, and 5) perspective-taking.

Embedded in the elaborations for the content learning standards for shapes/geometry, are many spatial reasoning concepts such as visualizing, locating, mapping, positionality and decomposing and composing shapes.

One way to develop an understanding of shapes and develop spatial reasoning is through investigations that are based on students' mathematical interests that honour where they are in their understanding. Inquiry-based learning experiences invite students to play with materials and ideas. These learning experiences are often named based on the intention of the experience – open questions, problems or tasks, explorations or invitations, provocation, and investigation or projects. Children need many opportunities over time to develop their understanding of shapes and to make connections across contexts, materials and representations.

The lessons included in this collection reflect an approach to the teaching and learning of mathematics that embeds inquiry and play elements that can be used across grades and provides a range of access and connection points.

BC Reggio-Inspired Mathematics Project

The BC Reggio-Inspired Mathematics Project is a collaborative professional inquiry involving teachers from several school districts in British Columbia. The project's goals are to bring teachers together from across districts, contexts and grades to think and learn together about how Reggio-Inspired principles and practices might enhance the teaching and learning of mathematics.

The Reggio Emilia Approach® is an approach to teaching and learning developed post-World War II in the northern Italy town of Reggio Emilia. It is an educational philosophy based on the image of a child with strong potentialities and competence, who learns through the hundred languages that is in all of us, and grows in community in relationship with others. In Reggio Emilia, this approach is enacted in infant, toddler and preschool and childcare centres as well as in one school-aged environment.

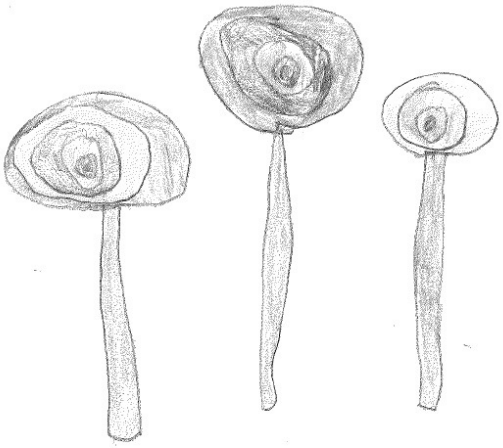
The following principles and practices inform and inspire our project:

Reggio Emilia education philosophy and principles:

- developed by Loris Malaguzzi and the parents and educators in the community
- viewing the child as capable, competent and having rights – that the child has a hundred or more languages to express ideas
- environment as third teacher, encounters with materials
- pedagogy of listening
- honours children's thinking
- responsive, emergent curriculum
- socially constructed learning, collaborative, in community
- importance of relationships

Reggio-inspired practices:

- the 100 languages of children
- connectedness
  - culture, community, environment
- the environment as third teacher
- emergent curriculum
- inquiry-based
- loose parts & natural materials
- interdisciplinary projects/investigations
- documentation
  - teacher as researcher
  - making learning visible



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BC Mathematics Curriculum Connections

BC Mathematics Big Idea:

We can describe, measure, and compare spatial relationships..

Questions to inspire student inquiry:

What do you notice about these shapes?
How are these shapes alike and different?
What stories live in these shapes?
What 3D shapes can you find in nature?
What 2D shapes live in objects in our world?
How can you combine shapes to make new shapes?
Where do 2D shapes live in 3D shapes?
How do the properties of shapes contribute to buildings and designs?

BC Mathematics Curricular Content:

- single attributes of 2D shapes and 3D objects (Kindergarten)
- comparison of 2D shapes and 3D objects (grade 1)
- multiple attributes of 2D shapes and 3D objects (grade 2)
- construction of 3D objects (grade 3)
- regular and irregular polygons (grade 4)
- line symmetry (grade 4)
- classification of prisms and pyramids (grade 5)
- single transformations (grade 5)

BC Mathematics Curricular Competencies:

Although many mathematics curricular competencies will develop through these learning experiences, we have choose the following three curricular competencies to focus on:

- use reasoning to explore and make connections
- visualize to explore mathematical concepts
- communicate mathematical thinking in many ways.

Core Competencies

Core competencies that will be focused on during these lessons include Communication, Collaboration and Creative Thinking.

First Peoples Principles of Learning

Many of these learning experiences aim to be holistic and interdisciplinary in nature. We have hoped to enact the following principle in our planning:
"Learning is holistic, reflexive, reflective, experiential, and relational (focused on connectedness, on reciprocal relationships, and a sense of place)."

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Making and Finding Shapes

In this investigation, early primary students explore the attributes of 2D shapes, creating them with different materials. This investigation will take about one hour or could be divided over two periods of time.

Learning Intentions:

- Students will be able to explore and create 2D shapes using a variety of materials.
- Students will be able to describe 2D shapes *("This shape has 3 sides and 3 vertices.")*
- Students will be able to communicate their mathematical ideas concretely and pictorially.

Reggio-Inspired Principles and Practices:

- loose parts and natural materials
- emergent curriculum
- honours children's thinking

Materials:

- A collection of books about shapes.
- A variety of loose parts carefully chosen to support explorations with shapes such as pattern blocks, popsicle sticks, string and shaped buttons.
- A variety of materials to create and record shape pictures such as paper, pencils, crayons and shape stencils.

Lesson Flow:

Part A

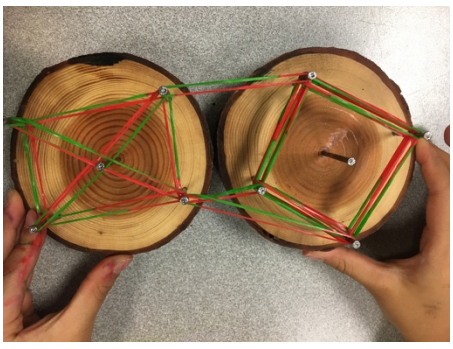
Project a WODB (Which One Doesn't Belong) image of 4 different shapes and have a group dialogue. Please see resources below for further information about the routine of WODB.

Part B

Set out a variety of materials and invite children to explore and create shapes on their own.

Some examples of materials that could be set out:

- A collection of books about shapes.
- Pattern blocks with pictures made from pattern blocks.
- A provocation with popsicle sticks.
- Geoboards and elastics.
- Flowers, magnifying glasses and recording materials.



Part C
Bring students together to share and reflect on their shape explorations. What shapes did you find in your explorations today? Invite students to share drawings or photos of their shape explorations. Ask students to turn and talk with a partner about which was their favourite shape exploration, what shapes they found and which shape materials they plan to explore next time.

Grade 4/5 Connections:
Students can use found materials to create polygons and explore the attributes of different polygons, both regular and irregular – quantity of sides, number of vertices, types of internal angles.

At-Home Learning	The above lesson can be done using an online platform such as Zoom to share the WODB image and have a discussion with students about observations or it could be shared on a class blog or sent by email. Invite students to explore shapes with materials found at home. Photos of students' work (shapes made with concrete objects and pictures drawn by students) can be emailed to the teacher or uploaded to e-portfolios.
Online Learning	Students can use virtual manipulatives such as this geoboard to create shapes. https://apps.mathlearningcenter.org/geoboard/ Students can take a screen shot or draw a picture to share their shape creations through email or posting to an e-portfolio.
Outdoors Learning	Students can go outside and use found objects in nature to make shapes. Students can also make shapes using their bodies and by making shadows.    Walk around the school and have students describe shapes they see in the playground, garden, school building, etc.

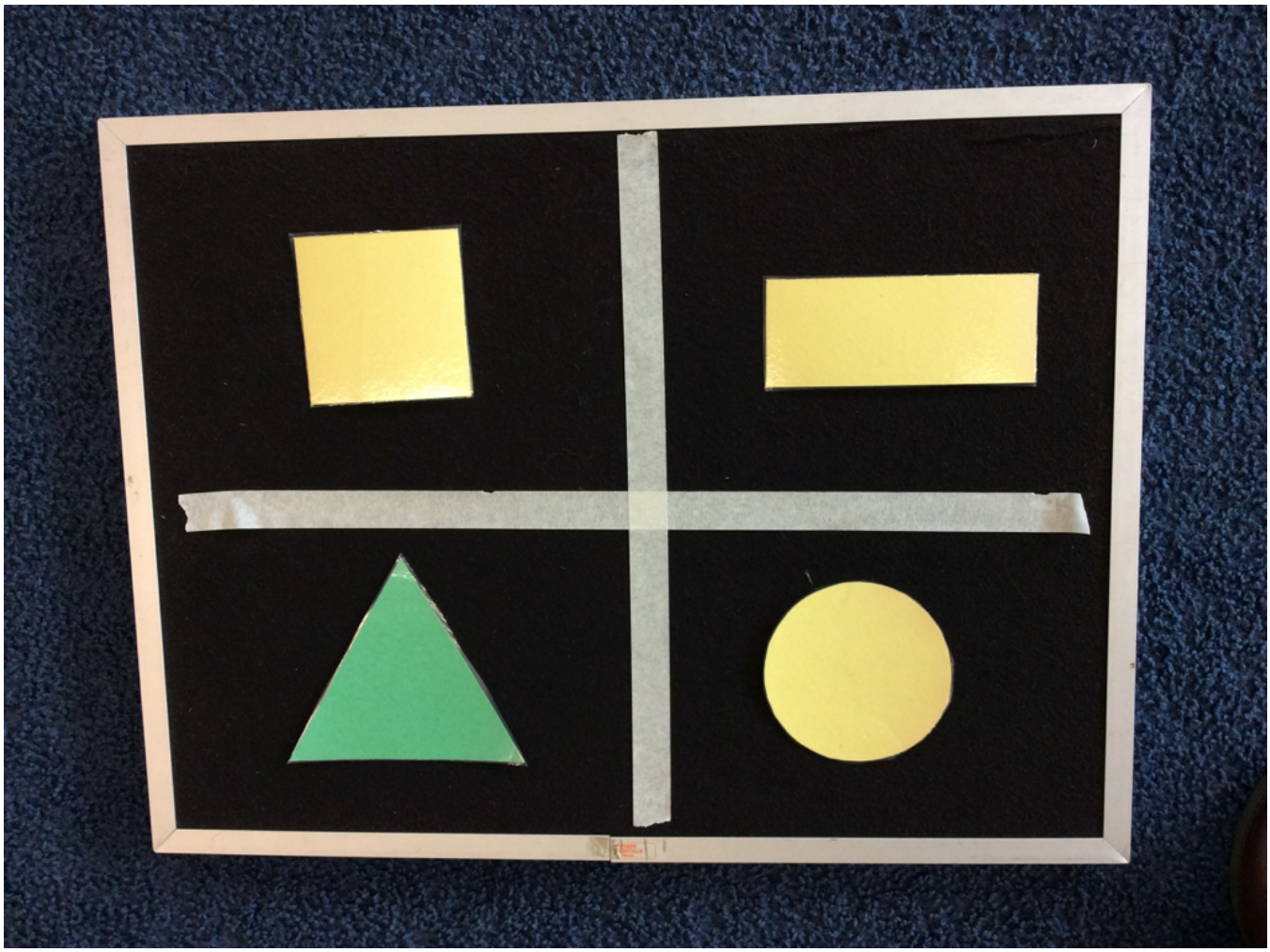
Resources:
Which One Doesn't Belong
http://www.meaningfulmathmoments.com/which-one-doesnt-belong-wodb.html

Children's Books:
Bear in a Square by Stella Blackstone
The Shape of Things by Dayle Ann Dodds
What is a Round? What is Square? What is a Triangle? by Rebecca Kai Dotlich

Assessment Questions:

- *Are students able to create 2D shapes using a variety of materials?*
- *Are students able to find 2D shapes in their environment?*

Which One Doesn't Belong?



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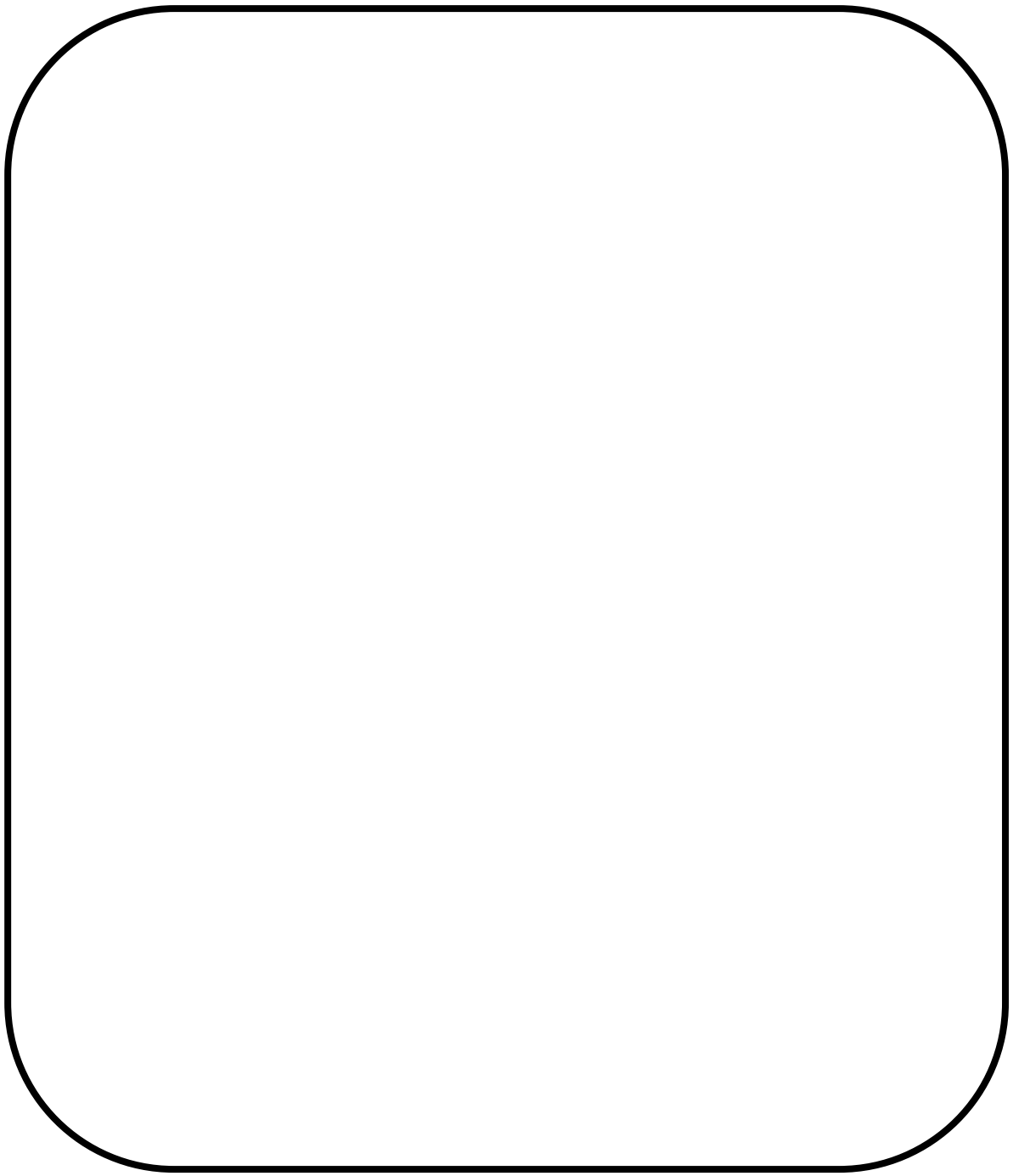
What shapes live in our playground?

Draw the shapes you find living in our playground.



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What 2D Shapes Can You Create?

This lesson focuses on having students develop flexibility in their understanding of 2D shapes. We want children to understand that not all 3-sided, 4-sided, or 5-sided shapes look the same. We want to avoid students thinking that that all triangles look like equilateral triangles. This lesson will provide children with opportunities to play with the sides and vertices of different 2D shapes.

Learning Intentions:

- Students will develop flexibility in their understanding of 2D shapes, using visualization as a way to think about shapes.
- The students will be able to describe and compare different attributes of 2D shapes.

Reggio-Inspired Principles and Practices:

- encounters with materials
- pedagogy of listening
- honouring children's thinking

Materials:

A variety of different materials for students to explore and use to create 2D shapes (i.e. geoboards, white boards, iPad, popsicle sticks, pipe cleaners, pencils, rulers, construction paper, scissors, etc.).

Lesson Flow:

1. Begin the lesson with a Which One Doesn't Belong? with different 2D shapes. If you are not familiar with a WODB, see the website at wodb.ca). As students are engaging in the discussion, reinforce the terms like sides and vertices as well as different vocabulary to compare shapes.
2. After the discussion, as a whole class, provide the students with a material to create different 2D shapes (i.e. geoboards, whiteboard, iPad with online virtual tools, paper and pencil). Ask the students to create different three-sided shapes. Can you create the shape with all the same lengths of sides? Can you create it with two sides the same length or all different lengths? Invite students to visualize what the shape will look like and describe it before they create it with materials. How many vertices are in each shape? Try other shapes. How many different four-sided shapes can you make? How many vertices does each have? Is the number of sides always equal to the number of vertices?
3. Provide the students with a variety of materials to explore making different 2D shapes. As the students are building, ask questions like how many sides or vertices are in your shape? Challenge the students to create different three-sided, four-sided, and other sided shapes.

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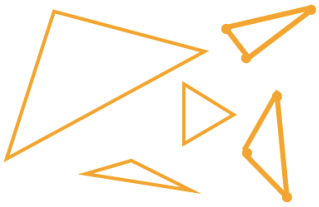
Grades 4&5 connections:
Students could explore different polygons. How many different 7, 8, or 9-sided shapes can you create? Students could also determine the area and perimeter of their shapes.

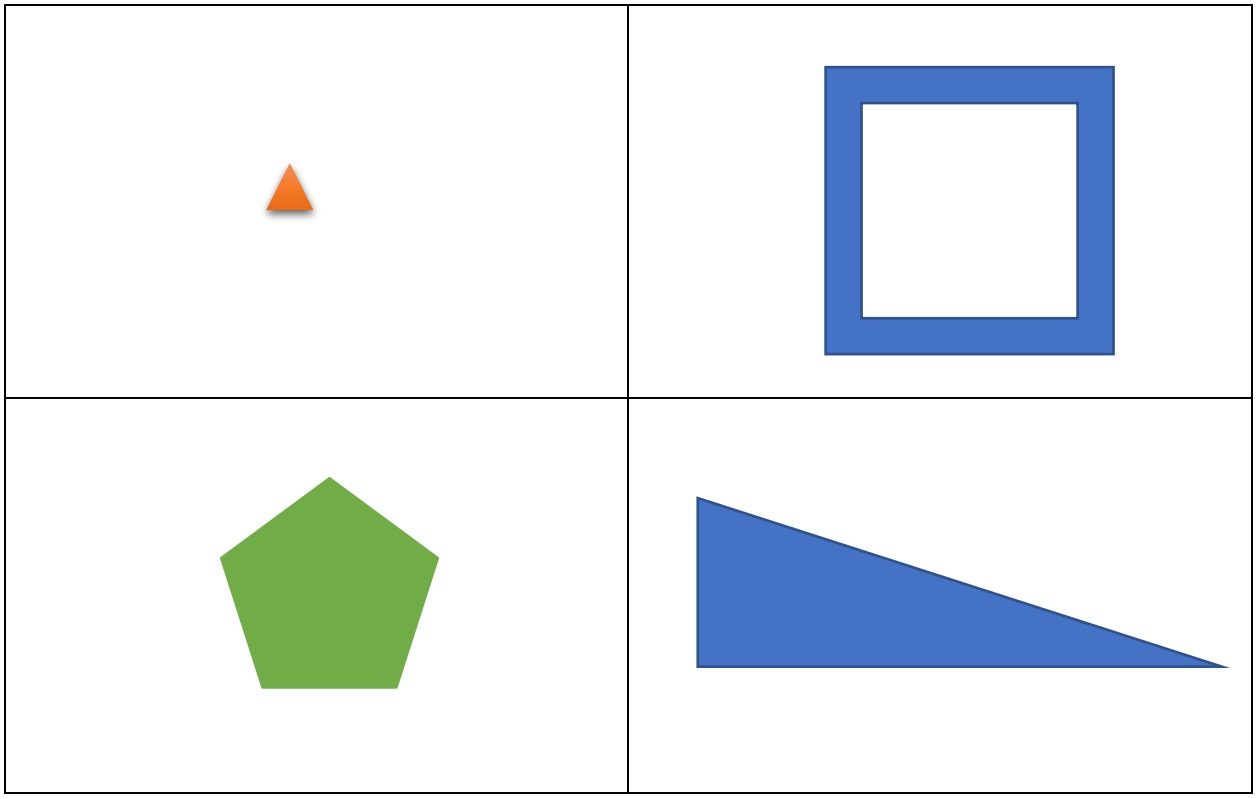
At-Home Learning	This lesson could be easily adapted to learning at home. On an online platform, students could engage with the first two parts of the lesson. The students could then use materials at home to create different 2D shapes.
Online Learning	Use the notepad on the virtual math tool on Mathies.ca or geoboards on the virtual tool Toytheater.com for students to create different 2D shapes. 
Outdoor Learning	Students could go outside and create different 2D shapes with sticks or natural materials. 

Resources:
Taking Shape: Activities to Support Geometric and Spatial Thinking K-2 by Joan Moss, Bruce et al., 2016. (teacher resource)
The Greedy Triangle by Marilyn Burns (picture book)

Assessment:

- *Are the students able to effectively communicate their flexibility in describing and comparing different attributes of 2D shapes using different forms of communication?*
- *Are the students able to successfully create 2D shapes with different attributes using visualizing to compare and think about different shapes?*

Which One Doesn't Belong



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Exploring 2D Shapes

How many different ways can you represent each shape?

three-sided shapes	four-sided shapes
Do all the shapes have three vertices?	Do all the shapes have four vertices?

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Composing and Decomposing Shapes

The concept that shapes can be composed or decomposed into new shapes is an exciting revelation. What shapes live within other shapes? Students may have previously explored with a similar concept in our investigations with place values – What numbers live within bigger numbers? This lesson can be done in a single day or extended over a few days as the inquiry progresses.

Learning Intentions:

- Students will be able to replicate 2D shapes and 3D objects (e.g., putting two triangles together to make a square).
- Students will use reasoning to explore strategies to compose and decompose 2D shapes and 3D objects .

Reggio-Inspired Principles and Practices:

- inquiry based learning
- encounters with materials
- honouring children's thinking

Materials:

- Paper cut into squares, scissors
- Writing utensils
- Geoboards

Lesson Flow:

1. Introduce an optical illusion puzzle to introduce the idea that shapes can live within other shapes. How many triangles do you see in this picture? How do you know you've found them all?
2. Provide students with a single square and have them cut it into 2 triangles. Encourage students to think about what they can make with those triangles. Then give the students 10 or 20 more squares to explore with. Investigation prompts may include: *Can you make a rectangle? What's the biggest/smallest rectangle you can make? How can shapes be decomposed or broken down into smaller shapes? How can you combine shapes to create other shapes?*
3. Bring students together at the end of the exploration time and ask for examples of their creations. Record ideas on a whiteboard or chalkboard or by taking photos of student work. It may be possible to ask: *What is the same / different with the shapes we created today? If we were to do this task again, what other shapes could we decompose?*

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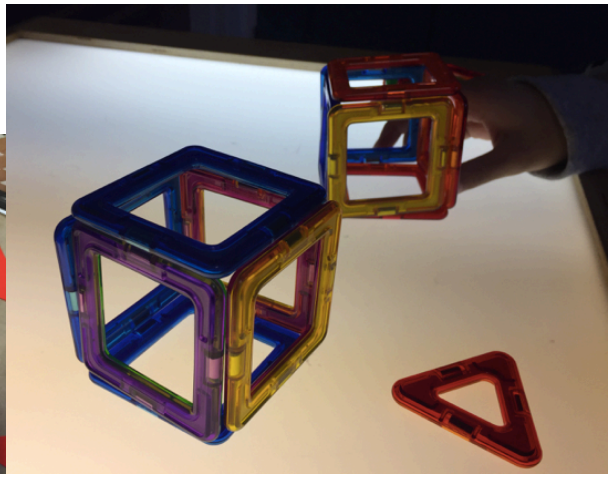
4. In the following days, read the Perfect Square book by Michael Hall. Provide students with various materials to explore composing and decomposing shapes (e.g., geoboards, pattern blocks, loose parts). Investigation prompts could include: *How might these materials help you think about composing and decomposing shapes? What is the same / different?*



Grade 4/5 Ideas:

Encourage students to use geoboards and grid paper to create, represent, measure and calculate the perimeter of their shapes. By composing and decomposing your shapes into new shapes, how has the perimeter changed?

At-Home Learning	During video conferences, display shape images from the Same but Different website and discuss how the shapes are the same /different. Invite students to draw a picture or take a photo of a shape in their home that they could decompose into a different shape. Upload to classroom platform and use a discussion point during small group video conferences.
Online Learning	Same but Different Thinking routine: https://www.samebutdifferentmath.com/geometry Use online apps to explore with composing and decomposing shapes, such as: https://www.mathlearningcenter.org/resources/apps/geoboard
Outdoors Learning	Encourage students to go on a nature walk and locate shapes in their environment. *Can you find shapes within natural structures?*

Resources:

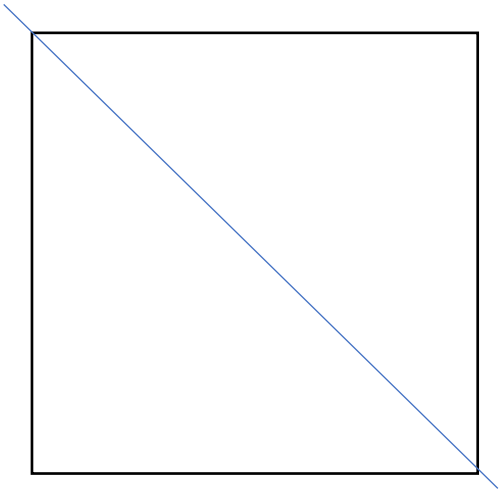
1. Taking Shape: Activities to Support Geometric and Spatial Thinking K-2 by Joan Moss, Cathy Bruce et al.
2. Same but Different Thinking routine: https://www.samebutdifferentmath.com/geometry

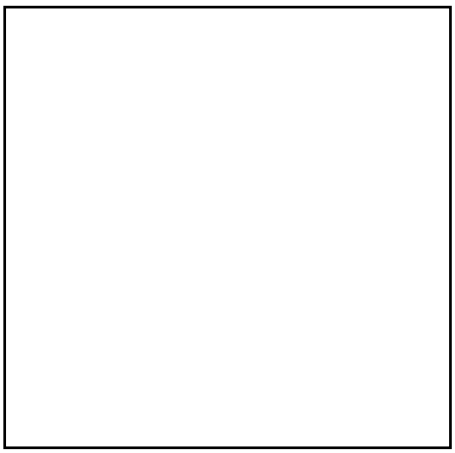
Assessment Questions:

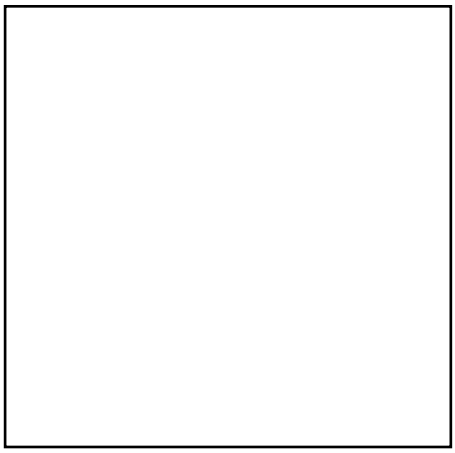
- *Can students effectively replicate 2D shapes and 3D objects?*
- *Can students successfully use reasoning to explore strategies to compose and decompose 2D shapes and 3D objects?*

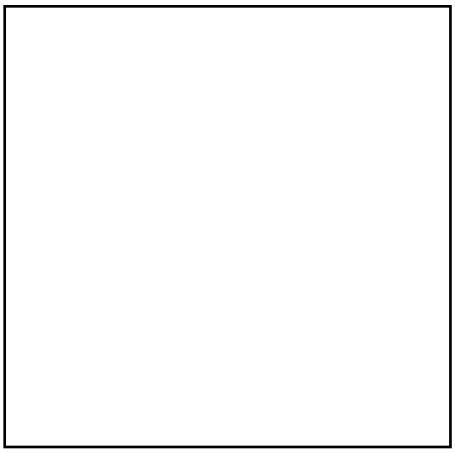
Composing and Decomposing Shapes

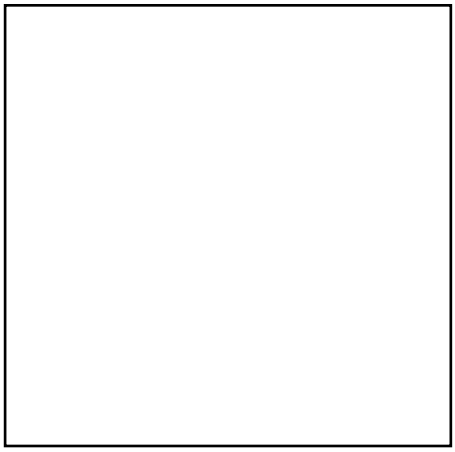
How can a square be decomposed to create different shapes?

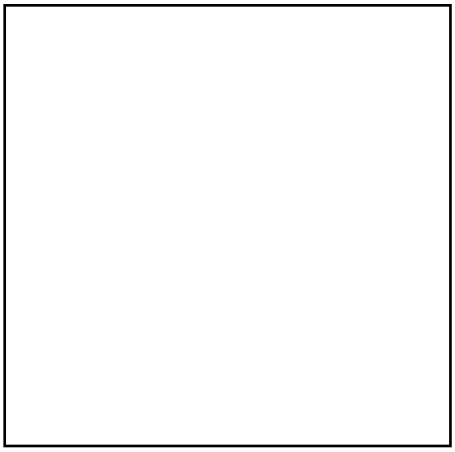












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Building 3D Shapes

This lesson focuses on having students make connections between the 3D objects they can find in the world around them and the 2D shapes that make up those objects. Shapes that are able to be manipulated such as nets or skeletons of three-dimensional shapes help students to see and feel how 2D shapes "live" in 3D shapes. This lesson is intended to take about an hour, with possibilities for revisiting the experience at another time with different materials.

Learning Intentions:

- Students will be able to find 3D objects and describe and compare them using mathematical language.
- Students will be able to manipulate and create 3D nets of shapes.
- Students will be able to identify the 2D shapes used to come together to make 3D shapes.

Reggio-Inspired Principles and Practices:

- honouring children's thinking
- connections
- use of materials
- collaboration

Materials:

1) 3D objects such as boxes and 3D math models.
2) Newspaper, magazines, straws, chopsticks, tape, masking tape and other found materials.
3) Commercial materials such as Straws and Connectors.

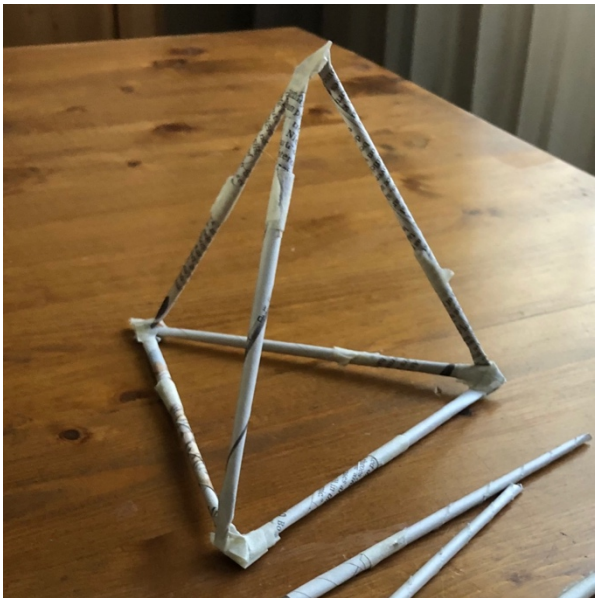
Lesson Flow:

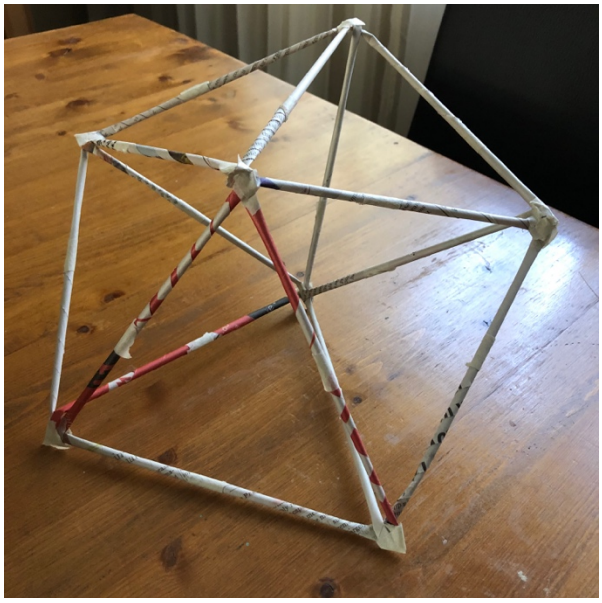
1) Invite students to bring a 3D object from home or find a 3D object or shape in the classroom or school. With a partner have the students describe and compare their objects using the thinking frames: How are they the same? How are they different? What connections are you making?
2) Ask students to consider: What 2D shapes can you find in your object? Invite students to share and show the shapes with a partner.
3) Introduce the idea of a 3D frame, net or skeleton by showing a box (something like a cereal or cracker box) and asking students to visualize what 2D shapes make up the box and to try and visualize what it would look like if it was cut open. Ask students to share their thinking.
4) Cut up two or three edges of the box so that you can lay the "net" flat. Ask students to describe what they see and what they are wondering

about. Ask students what the terms frame or skeleton might refer to and what connections they are making. Show, draw or explain a 3D skeleton.

5) Invite students to work together in small groups to draw and label a plan and then choose or find materials that they could use to create 3D nets, frames or skeletons of their 3D object or another 3D object or 3D geometric model. Have students consider the affordances of different materials and what tools or adhesives they will to connect or attach the materials together. Provide time for students to explore the materials and investigate the design and process of building a 3D construction.
6) Create a 3D construction gallery in either a physical or virtual space, with students adding a title, list of materials and a mathematicians' statement.

*As an extension, students can be encouraged to combine shapes to make new shapes and to consider composing and decomposing both 2D and 3D shapes in the process.





Grades 4&5 Ideas:
Encourage students to find or construct different 3D shapes (skeletons, nets or solids) with varying polygons for the faces. Why might some boxes be created in rectangular prisms while others are triangular or hexagonal prisms? Where are prisms and pyramids found in the classroom, at home or in the community? Create a photo collage or drawings of the 3D shapes students find.

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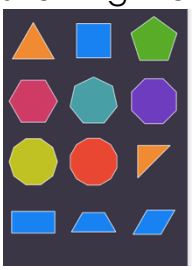
At-Home Learning	What 3D objects can your students find at home? What 2D shapes live in 3D objects. Students can take photos or draw and label the shapes they find.  Have children find materials from around their home to create with. What materials could be re-used or re-purposed? Have children consider what they can use their 3D creation for. Could you they had 2D paper shapes to cover the faces to make a tent or a home for a pet or a stuffed animal or toy?
Online Learning	Students can use virtual manipulatives such as these: https://mathigon.org/polypad to create nets of 3D shapes, showing the 2D shapes that they are comprised of.   Students can post their nets with word labels to an online sharing platform, to a class blog or their e-portfolios.
Outdoors Learning	Have children collect sticks and twigs outdoors and whittle them or cut them to create similar lengths. Use twine or string to tie sticks together to make 3D shapes. 

Resources:

1) Geogebra has a collection of videos and animations about how to create nets of 3D solids/shapes. https://www.geogebra.org/m/pCv2EvwD
2) Taking Shape: Activities to Support Geometric and Spatial Thinking K-2 by Joan Moss, Bruce et al., 2016. (teacher resource)

Assessment Questions:

- *Are students able to successfully identify the 2D shapes or their attributes that make up a 3D net and make connections as they compare 3D nets and shapes?*
- *Are students able to effectively communicate their understanding of 3D objects and shapes using mathematical language and vocabulary, concrete materials and gestures?*

Building 3D Shapes

Draw your plan:

What materials will you need?

Draw a representation of your 3D shape:

What 2D shapes do you see?

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Where Do Shapes Live in Structures?

Students have had many opportunities to explore with 3D shapes. They have created structures and have thought about which 2D shapes live in 3D shapes. They are starting to make connections between shapes and the world around us. The students look closely to find 2D and 3D shapes in structures they build and in structures found in our world. *How does knowing about shapes help us build with blocks? What shapes live in buildings and structures?*

Learning Intentions:

- Students will be able to explore, create and describe 2D and 3D shapes.
- Students will be able to describe and build with 3D shapes found in familiar structures.
- Students will be able to connect mathematical ideas to their place.

Reggio-Inspired Principles and Practices:

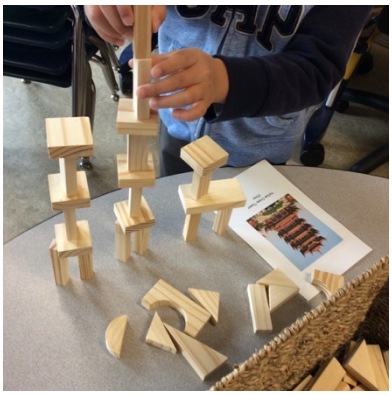
- loose parts and natural materials
- connected to community
- interdisciplinary project

Materials:

1. Images of local structures and famous world-wide structures to project on the screen.
2. Building blocks including a variety of 3D shapes.
3. Photos of structures and buildings printed on cardstock.
4. Recycled containers to build with.

Lesson Flow:

1. Project images of a structures on a screen or look at large photos of structures. Look at photos of structures and buildings found in the neighbourhood. Show images of famous structures in the world and be sure to include images of structures from different places in the world where the families in the class have come from. Questions to consider together: *What do you notice? What do you wonder? What 2D shapes do you see? What 3D shapes do you see?*



2. Provide students with a variety of materials to explore the connections between shapes and structures such as small blocks, large building blocks and empty containers. Students are invited to build with materials of their choosing on the tables or on the floor. Students may use photos of structures provided to reproduce those structures or to use as an inspiration for their own structures.

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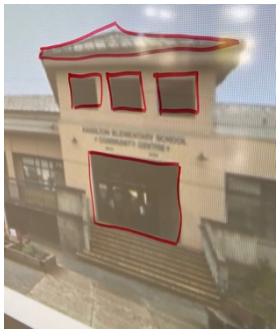
3. Some students may be interested in making a record of their structure by taking a photo or drawing a picture of it on paper.
4. Bring students together to reflect on their building explorations. Project a photo of a student's structure or have a student show a drawing they made to represent their structure. Invite students to share discoveries they have made about shapes living in structures. *What shape did you build with the most? What shapes were difficult to include in your structure? What shapes went together easily?*

Grade 4/5 Connections:
Encourage students to specifically identify and name the prisms and pyramids they are using in their buildings. Invite students to find examples of structures or parts of structures that have line symmetry and recreate these with materials.

At-Home Learning	The lesson above can be introduced by sharing digital images of structures with students at home – email or an online platform such as blog post or through video conferencing. Students are invited to create structures using building sets and empty containers from their recycling bin.   I made a bridge like the Alex Fraser Bridge.
Online Learning	 Use the "CUBE" building virtual manipulative to create different structures: https://toytheater.com/cube/
Outdoors Learning	Take students outside and find a spot to sit where they can see the school building or playground structure. Ask students questions to provoke their mathematical thinking such as: *What shapes do you see? What do you notice about the shapes? What do you wonder about the shapes?* Invite students to share their observations about the shapes with the group.  Students can gather found objects in nature and build a structure inspired by the one observed or of their own design. Take photos of the structures seen and built to revisit when back inside the building.

Resources:

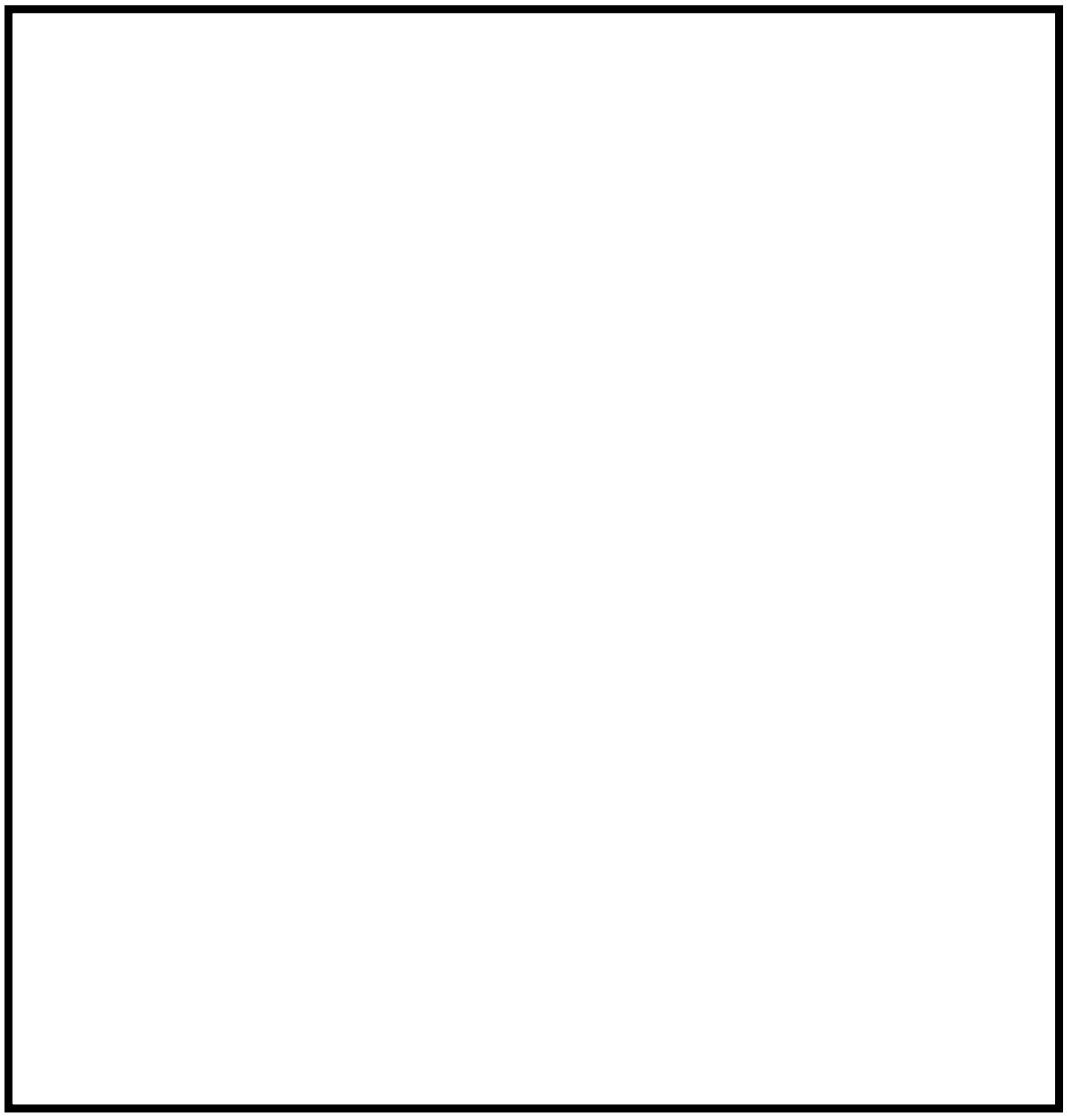
- The Shape of the World by K.L. Going

Assessment Questions:

1. *Are students able to explore, create and describe 2D and 3D shapes?*
2. *Are students able to describe 2D and 3D shapes found in local structures and buildings?*

This is one of my favourite structures in my neighbourhood. It is _____.

Here is my plan for how I am going to build it using loose parts and containers from my recycling bin.



By _____

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Shapes Found in Nature

This lesson focuses on having students make connections between the traditional geometric shapes they have learned about and the more organic shapes that are found in nature and may be represented in the art of local Indigenous artists. This lesson is intended to take about an hour, with possibilities for revisiting the experience at another time with different materials or in different locations.

Learning Intentions:

- Students will be notice and record shapes found in nature and how those shapes are represented in art.
- Students will be able to discuss and compare similarities and differences between geometric shapes and shapes found in nature.
- Students will be able to use mathematical and geometric language to describe organic shapes found in nature.

Reggio-Inspired Principles and Practices:

- honouring children's thinking
- connections to place, community and culture
- use of materials

Materials:

- Clipboards with paper and pencils or whiteboards and markers.
- Devices to take photographs.
- Materials to create and represent with such as pencil crayons, paint, charcoal, clay, loose parts, etc

Lesson Flow:

1) Take students outside where they can observe the shapes in plants, trees, shells, driftwood, stones, etc. Spend time noticing the shapes that are found in the natural environment and have students record their observations using pencils and paper or on whiteboards. Take photographs to re-visit at another time. Have students notice shapes within shapes.
2) Gather students together and invite them to share the shapes they found with a partner or small group of classmates and consider and discuss these questions: *What language could you use to describe your shapes? How do you think weather, water and the local environment contributes to the creation of the shapes you are noticing? What connections are you making to the geometric shapes you might know about?*
3) Invite students to choose a material to use to further think about and represent the shapes they found outdoors.

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4) Look at works of art from a local Indigenous artist to notice the shapes that are used in painting, carvings, sculpture and weaving. Different cultural groups use different shapes and forms in their art, for example, in Coast Salish art forms, there are three significant shapes: circle, crescent and curved triangle/trigon. In northern cultural groups such as Haida, the ovoid is a significant shape and in the Interior, shapes and forms of significance are seen in pictographs, stone sculptures and pit houses. Have students share what they are noticing and connections they are making to the shapes they found outdoors and the materials used.

*As an extension, students can choose an artist to further research and create a gallery or installation that represents and raises awareness about their work.

Inspired by Susan Point's spindle whorl designs, students used Coast Salish shapes to create their own designs.

Murals in Vancouver created by local Indigenous artists.

Grades 4&5 Ideas:
Have students make math-to-math connections by connecting shapes and patterns. What growth patterns do you notice in the way the shapes of the part of a fern grow? What about the shapes of trees? How could you represent these shapes and patterns?

At-Home Learning	Invite students to look out their window, visit a local park or go for a walk in their neighbourhood and notice the shapes found in plants and trees. Have them record their observations using photographs or drawings and describe them using mathematical language.
Online Learning	Visit an online gallery of Indigenous art (see resource list below for some suggestions) and have students notice and record their observations of the shapes found in the works of art, making connections to what these shapes might represent or symbolize.
Outdoors Learning	Parts of this lesson are spent outdoors, noticing and recording shapes found in nature. Also, students could use field guides for local trees and plants to identify how shapes and symmetry in leaves are used to identify specific species.

Resources:

- Vancouver Mural Fest – many contemporary Indigenous artists have created murals over the years for this event and images are curated on this website: https://vanmuralfest.ca/highlighting-indigenous-artists
    - A map of locations (click on location to see image) of murals created in the Vancouver area by Indigenous artists can be found here: https://www.google.com/maps/d/u/0/viewer?mid=1vDMO1CVlC2ODleYXSn4dRP7VxSAvMw4z&ll=49.27009389319408%2C-123.11045895000001&z=14
- The Tree Book: Learning to Recognize Trees of British Columbia, online version available here: https://www.for.gov.bc.ca/hfd/library/documents/treebook/
- Susan Point's website which includes galleries of her works: https://susanpoint.com
- Northwest Coast Painted Designs, a K-3 educator resource from the Bill Reid Centre: https://www.sfu.ca/brc/educator-resources/paint_grades-k-to-3.html

Assessment Questions:

- *Are students able to successfully compare and describe the attributes of geometric shapes with the more organic shapes they find in the natural environment?*
- *Are students able to effectively describe and communicate observations of shapes in the natural environment using mathematical language and vocabulary, concrete materials and gestures?*

Shapes Found in Nature

Draw some shapes found in nature:

What words could you use to describe these shapes:

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Robot Design Project

Most robots do jobs that people cannot or do not want to do. Their jobs determine what they look like. This design project will provide students with the opportunity to visualize, draw and construct their own 2D and 3D robots. This project could be used as a way to conclude a geometry inquiry (after the children have had an opportunity to sort, draw, build and investigate 2D and 3D shapes). This lesson will take numerous days to complete.

Learning Intentions:

- The students will be able to visualize, draw and construct their own 2D and 3D robots.
- The students will be able to identify and compare different attributes of 2D and 3D shapes.

Reggio-Inspired Principles and Practices:

- inquiry based
- encounter with materials
- interdisciplinary project

Materials:

1. Google images for different robots.
2. Books about robots or devices so that students could research robots.
3. Paper, rulers, glue, tape, recycled materials (i.e. boxes, plastic cups, containers, tin cans).

Lesson Flow:

1. Introduce the students to the Robot Design Project. Discuss how robots are designed for specific jobs. Share some Google images and videos of different robots with the students. What 2D and 3D shapes do they see in the robots? How do their shapes help them perform their job?
2. Provide the students with some time to look at images, read and research about robots. What shapes and sizes make up the different robots? How does the robot's purpose determine the shape and size of the robot?
3. Students will visualize, design and draw a labelled diagram of their robot.
   Possible Questions:
   What job will your robot do?
   What features will your robot need to complete their job?
   What shapes and sizes will these features need to be?
4. As a class, brainstorm different criteria for the robots:
   Some possible examples:
   -must contain at least three different 3D shapes
   -must contain at least two 3D shapes you construct by yourself
   -must include measurements of your robot

*Extension: you could include different math concepts into your criteria (i.e. some part of the robot must be symmetrical or have a pattern).

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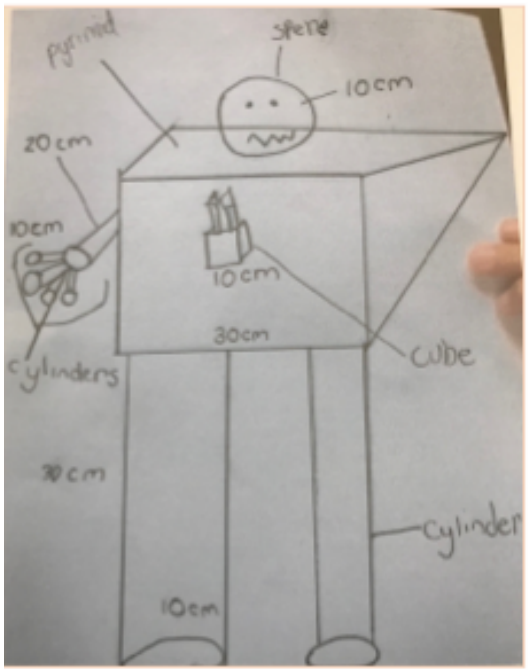


This student created a robot that would do art with her. She sometimes gets lonely when she does art at home, so this robot would keep her company. The robot would even play music and hold art supplies. The head is a camera, so it could take pictures of the art they create together. She chose these measurements so that it would be small enough to sit on her desk and work with her.

5. The students will use their 2D drawings to guide them in creating 3D models of their robots. What 3D recycled materials can you use to build your robots? What 3D shapes will you need to create by yourself using paper? How will knowing about 2D shapes help you create the 3D shapes?

6. After completing their robots, the students can use recording sheets or a notebook/journal to determine and record the different shapes and measurements. What 2D and 3D shapes can be found in their robots?

Grades 4&5 Connections:
Students could determine the area and perimeter of different parts of their robots and consider the types of prisms needed to create their robots. Using the online TINKERCAD platform (https://www.tinkercad.com), students can construct their robots and potentially 3D print them.

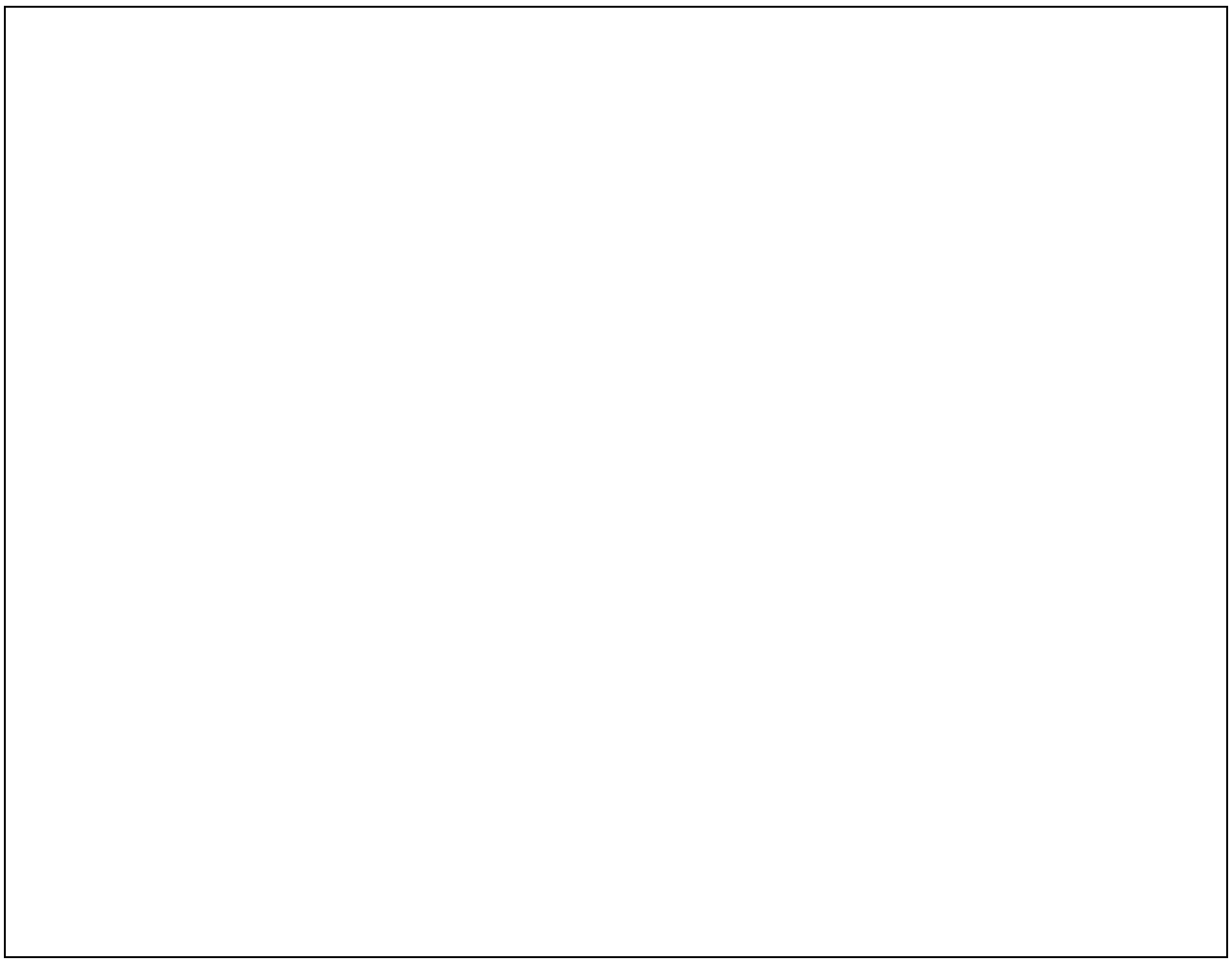
At-Home Learning	Students could be provided with the overview of the project via an online platform, email or blog post or phone conversation. They could be encouraged to visit a local library to find books or resources about robots. The students could draw and build their robot using materials they can find at home.
Online Learning	Students could engage in the first part of the lesson on an online platform. As a class, they could watch the video, look at the Google images of different robots and be introduced to the project. Over the course of a few days, the students could draw and build their robot using materials at home or using an online drawing program. Video: Real-Life Robots https://www.youtube.com/watch?v=8wHJjLMnikU
Outdoor Learning	The students could spend time outside finding places that robots could be used. How could robots be used in the natural world or to help the environment? What problems or jobs need to be completed outside that robots could help with? What materials could you find outside to build a robot with? How are the shapes you find outside the same and different than geometric shapes?

Resources:
Taking Shape: Activities to Support Geometric and Spatial Thinking K-2 by Joan Moss, Bruce et al., 2016. (teacher resource)

Assessment Questions:
- *Are the students able to effectively communicate their understanding of 2D and 3D shapes while describing their robots?*
- *Are the students able to visualize, draw and construct their robots?*
- *Are the students able to use their understanding of 2D shapes to help them construct different 3D shapes?*

My 2D Robot Design

Draw a labeled diagram of your robot.



What job does your robot have?

What special features does your robot have that helps them do their job? Why did you choose the different shapes and sizes for your robot?

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My 3D Robot Design

What 2D shapes are in your robot?

What 3D shapes are in your robot?

Mapping and Spatial Reasoning

Spatial reasoning involves critical thinking and visualization that helps us understand where objects are in relation to ourselves. It helps students develop their visualization skills and is a precursor to geometric, algebraic and proportional thinking. Among its many purposes, it is essential when reading and creating maps. Introducing mapping through storytelling and personal experiences allows for multiple entry points for students. This lesson will take several days to allow for sufficient practice and scaffolding of different mapping concepts and experiences.

Learning Intentions:

- Students will be able to describe relative positions by using positional language (e.g., beside, in front, behind)
- Students will develop their visualization skills through exploring with a variety of materials and representing their ideas in concrete, pictorial, and symbolic forms

Reggio-Inspired Principles and Practices:

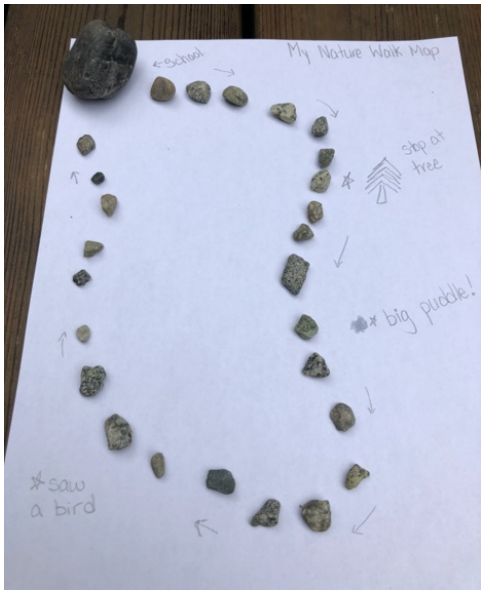
- choice
- connectedness to community
- environment as the third teacher

Materials:

- My Map Book by Sara Fanelli
- A variety of loose parts such as blocks, gems, rocks, twigs, Lego, rods and connecters, paint, black lined markers, etc.
- Mapping recording sheets or grid paper

Lesson Flow:

1. As a class, brainstorm where and why they have ever needed to use a map. Was it easy or difficult to follow? Take the class for a short nature walk around your school grounds, highlighting different areas along the way and discuss how we could map these different areas.
2. Provide a variety of materials to allow students to explore mapping their experiences during the nature walk. These could include blocks, gems, rocks, sticks, etc. While students are exploring



with map making, encourage students to include directionality language like in front, beside, on top, etc.

3. In the following days, discuss if there are there other ways we can make maps. Read My Map book and brainstorm the different types of maps we can create (e.g., Map of my heart, Map of my classroom, Map of my favourite story, etc).
4. Students can choose which type of map they would like to make. Encourage students to use a variety of materials to create their maps. Invite students to label their maps using positional and descriptive language (e.g., the circular rock was beside the rectangular pathway).

Grade 4/5 Ideas:

Invite students to represent their maps on geoboards or grid paper to support their understanding of how to represent, measure, and calculate perimeter. Encourage students to include line symmetry, ratios and perspectives in their maps. Mapping is an contextual opportunity to introduce transformations as students consider how to place objects on their maps or navigate directions.

At-Home Learning	Through video conferencing, class blog or email, brainstorm ways and places students can map their homes. This could include their kitchen, living room, bedroom, etc. Prompt students to label their maps using positional language (e.g., the plates are in the cupboard to the right of the fridge).
Online Learning	Students can explore different ways of reading maps by exploring Google Maps or the National Geographic website (https://www.nationalgeographic.org/education/map-skills-elementary-students/) Using an online drawing website, such as https://kidmons.com/game/paint-online/ , students can create maps at home and then save to their class' online platform to share with their peers and teacher.
Outdoors Learning	Invite students to find a special area in nature near their home and map the area and their experiences there. Watch the nature video for some inspiration. https://youtu.be/nh1UluUAl7A

Resources:

Nature Mapping Video: https://youtu.be/nh1UluUAl7A

National Geographic website with Mapping Lessons: https://www.nationalgeographic.org/education/map-skills-elementary-students/

Assessment Questions:

- *Can students effectively describe relative positions by using positional language (e.g., beside, in front, behind)?*
- *Can students successfully use their visualization skills by representing their maps in concrete, pictorial, and symbolic forms?*

Mapping Our Nature Walk

Using pictures, numbers and labels, can you use the space below to draw a map of your nature walk experience?

Spatial thinking words you may want to use:

Left	Right	In front	Beside
North	South	East	West
Circular	Rectangular	Close	Far Away

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Mapping Familiar Places

Using pictures, numbers and labels, can you use the space below to draw a map of a familiar place? How do the grids help with map making?

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Appendix A: Assessment of Student Learning

In each lesson on the previous pages of this collection, there are two to three formative assessment prompts for teachers to reflect on, to inform their planning.

In this Appendix, there is a proficiency assessment table for each grade level, specific to the areas of focus for this collection of lessons.

There are three parts to each proficiency assessment table:

1) In each table the grade level mathematics learning standards, both curricular content and curricular competencies, are included.

2) There are indicators of proficiency that include both content and competencies. Please note that all indicators may not apply to all lessons. These statements what a student is able to do if they are proficient in this area of mathematics for their grade level.

3) There is a student learning story which describes a learning engagement from one of the lessons, including some or all of the following: the students' observable actions, conversations the teacher had with the student and a product, drawing or creation from the student.

The purpose of the proficiency table is to be able to provide information for teachers to create a class profile of where their students are in their learning, in relation to the goal of reaching proficiency in regards to the learning standards. The indicators of proficiency can also be used to provide feedback to students and to support their engagement in setting learning goals.

Indicators of proficiency and learning stories were developed through observations, interviews and collection of work samples with students of teachers in our project.

Kindergarten

Kindergarten Learning Standards	Indicators of Proficiency
Content: • single attributes of 2D shapes and 3D objects **Competencies:** • use reasoning to explore and make connections • visualize to explore mathematical concepts • communicate mathematical thinking in many ways	A student can explore, create and describe a 2D shape or 3D objects in many ways using concrete materials, drawing and oral language. A student can successfully describe 2D shapes and 3D objects using single attributes such as quantity of sides/edges, number of corners/vertices, curved or straight lines, etc. A student can make connections by finding and describing 2D shapes in the environment (in the classroom, outdoor, etc) A student can successfully create a mental picture (visualize) and describe a 2D shape or 3D object or how a shape or object will look when its position is changed.

Student Learning Story:

A kindergarten student is using popsicle sticks to create shapes and then use those shapes to make pictures.

Teacher: "What do you think it will look like if you put that on top of the other shape?"
Student: "It will be slanty, like a roof."

The student slides the triangle they created over to place on top of the square they had made.

Student: "Oh, I have an extra stick!"
Teacher: "Why do you think that is?"
Student" "Well my shapes went together. This is a triangle and I used three sticks but when I moved it, I didn't need the bottom. It was already there. The shapes are sharing that side."

Grade One

Grade One Learning Standards	Indicators of Proficiency
Content: • comparison of 2D shapes and 3D objects **Competencies:** • use reasoning to explore and make connections • visualize to explore mathematical concepts • communicate mathematical thinking in many ways	A student can explore, create, describe and compare 2D shape and 3D objects, communicating their thinking in more than one way (ie. pictures, numbers and words; concretely, pictorially or symbolically; or orally or in written form). A student can successfully sort 2D shapes and 3D objects by single attributes such as quantity of sides/edges, number of corners/vertices, curved or straight lines or size. A student can demonstrate reasoning by effectively comparing how two shapes or objects are the same or different, focusing on their attributes. A student can successfully create and describe a mental picture (visualize) of a second 2D shape or 3D object in order to compare it to one they are able to see or hold.

Student Learning Story:

A grade one student and a partner have collected twigs outside in the school park and create a collection of shapes.

Teacher: "Please tell me about your shapes."
Student: "They all have straight sides because of the sticks. These ones have three sides. They're triangles but some are different. These ones have four sides. This one has longer sticks."

The students each have a clipboard and draw the shapes they created.

Grade Two

Grade Two Learning Standards	Indicators of Proficiency
Content: • multiple attributes of 2D shapes and 3D objects **Competencies:** • use reasoning to explore and make connections • visualize to explore mathematical concepts • communicate mathematical thinking in many ways	A student can successfully explore, construct, describe, and identify 2D shapes and 3D objects, communicating their thinking in more than one way (ie. pictures, numbers and words; concretely, pictorially or symbolically; or orally or in written form). A student can successfully compare and sort 2D shapes and 3D objects by more than one attribute such as quantity of sides/edges, number of corners/vertices, curved or straight lines or size. A student can demonstrate reasoning by effectively comparing how two shapes or objects are the same or different, focusing on more than one attribute. A student can successfully create and describe a mental picture (visualize) of the 2D shapes they can see in a 3D object.

Student Learning Story:

The class looked at images of Coast Salish weaving designs and the students noticed there were many triangles. The teacher cut several pieces of origami paper in half and invited students to compose and decompose shapes with the triangles.

Student: "When I stack the triangles on top of each other it looks like a tree. I also made rectangles with the triangles. If I put two triangles together they make a square. And then I put two of those together to make a rectangle. And I could keep going."
Teacher: "Did you think it was going to make a square and then a rectangle?"
Student: "Well at first I thought three sides plus three sides would make six sides but they go together and this one inside."
Teacher: "I wonder what other shapes you can make with triangles?"
Student: "Well, I am going to keep going. Maybe there's more if I move them around."

Grade Three

Grade Three Learning Standards	Indicators of Proficiency
Content: • construction of 3D objects **Competencies:** • use reasoning to explore and make connections • visualize to explore mathematical concepts • communicate mathematical thinking in many ways	A student can successfully construct, describe and identify 3D objects using mathematical terms, communicating their thinking in more than one way (ie. pictures, numbers and words; concretely, pictorially or symbolically; or orally or in written form). A student can successfully identify the 2D shapes used to construct nets or skeletons of 3D objects. A student can demonstrate reasoning by effectively comparing and sorting 3D objects by their attributes: 2D faces, quantity and type of edges, quantity of vertices. A student can successfully create and describe a mental picture (visualize) of the 2D shapes they can see in different 3D objects.

Student Learning Story:

A grade three student attended an online learning session where the teacher showed the students how to make "sticks" using newspaper and then put these together to make frames/skeletons of 3D objects. The student created a "gem" using this method at home and discussed it with his teacher during a video conference during the week.

Teacher: "Please tell me about what you made."
Student: "It's a gem, like a diamond. I started by making small triangles and I put them together. It looked like a hat with a point at the top. And then I made longer triangles. I thought I was going to make a tower but I used all eight triangles to put this together and it had another point on the other end. Those are vertexes, right? Then my mom and I wondered if the other points were also vertexes."
Teacher: "Can you tell me more about the edges of your net?"
Student: "There's eight, four short and four long. No wait, then the connecting ones as well, That's a square shape so four more. They are all straight."

Appendix B: Suggested Resources

Teacher Resources:

Messy Maths by Juliet Robertson
Taking Shape: Activities to Support Geometric and Spatial Thinking K-2 by Joan Moss, Cathy Bruce et al., 2016
Open Questions for the Three-Part Lesson: Geometry and Spatial Sense K-3, 4-8 by Marian Small & Ryan Tackaberry

Online Resources, Websites and Apps:

BC Reggio-Inspired Mathematics Project
-blog posts, downloadables, planning guides, gallery, pedagogical content knowledge resources, patterning image gallery
http://bit.ly/reggioinspiredmath

Virtual Manipulatives
-various suites of virtual manipulatives can be used to create pictorial/visual representations of patterns
Math Learning Center: https://www.mathlearningcenter.org/resources/apps
Didax: https://www.didax.com/math/virtual-manipulatives.html
Toy Theatre: https://toytheater.com/category/teacher-tools/virtual-manipulatives/

Other Online Resources
desmos.com and desmos app for playing with transformations
Geogebra: online 3D net animations - https://www.geogebra.org/search/3D%20nets
Colour Tiles by mathies (app)
Symmetry Lab (app)

Children's Books:

Shaping Up Summer by Lizann Flatt
Circles, Stars and Squares: Looking for Shapes by Jane Brocket
Looking Down by Steve Jenkins
Seeing Symmetry by Loreen Leedy
The Shape of Things by Dayle Ann Dodds
Shapes, Reshape! by Silvia Borando
Changes, Changes by Pat Hutchins
Lucy in the City: A Story about Developing Spatial Skills by Julie Dillemuth
Which One Doesn't Belong? by Christopher Danielson