ST. ANDREW LESSON STUDY TEAM
TCDSB
Kindergarten to Grade 1
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Tapping into Symmetry:
A Lesson for JK/SK Students

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AGENDA

9:30 to 10:20	Introductions and background provided by the St. Andrew planning team
10:30 to 11:30	Public Lesson in a FDEL-K classroom
11:30	Lunch served (we will eat during the debrief)
11:45 to 12:45	Debrief: i. Teachers who taught lesson ii. Observations from teacher planning group iii. Comments from guests iv. Discussants

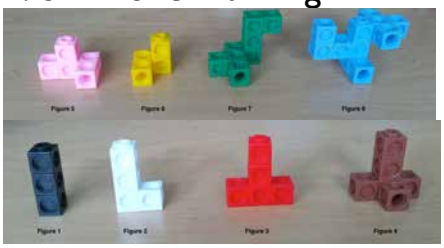
1. Teacher Knowledge Exploration

We spent a session trying different geometry activities and experienced the challenges that students might encounter:

- Pentominoe activities
- 3D block building: visualization, cube-challenge
- Tangrams puzzles
- Pattern Blocks, building symmetrical patterns
- Self-regulation (head, shoulders, knees, toes, task)

2. Teacher-Student One-to-One Interviews

The interview tasks were developed by the team in order to uncover students' early spatial sense. The teacher with the support of researchers and graduate students interviewed six students from each class. The interviews were videotaped and analyzed as a group. Our observations and findings motivated us to further explore children's spatial reasoning.

Task	Description
1. Composing/ Decomposing Shapes with Pattern Blocks 	*Part I: 2D Shape Task* Teacher presents child with all 6 shapes of pattern blocks (triangle, square, blue rhombus, beige diamond, trapezoid, hexagon). Using a sheet with outlined shapes (see Appendix A) the child is given a triangle and asked, **'Where does this shape belong on here** (point to the sheet with outlined shapes)**?'** Once the child has placed the shape over the outlined shape, the teacher asks, '**What would you call this shape? Can you tell me about this shape?'** This process is repeated using the orange square and moving on to the other shapes. *Part II: Filling Space* Present child with outlined shape and say, "Fill in this shape in as few blocks as possible." If the child does not understand the task, rephrase the question in a way that makes sense to the child. *Part III: Hexagon Challenge* **"Can you guess how many ways you can fill in this shape** (point to one of the hexagon shapes in the booklet) **using any of the shapes here** (point to the assortment of pattern blocks)**?"** After the child has offered a guess, ask child to **"go ahead and see how many *different* ways you can fill in these shapes** (pointing to the hexagon shapes)**."** After filling in one hexagon, encourage child to continue on to the next one. Stop testing if the child signals that they're finished with the task.
2. 3D Model Building 	Teacher shows each of the following figures individually in sequence from Figure 1 to Figure 8. Teacher says:**"Look at this object carefully. Without touching it, build it."** If child is unable to replicate object, say, **"It's not exactly the same. Try picking it up, really look at it carefully, and try to build it again."** Interview stops if child is unable to successfully re-create 2 attempted figures. *Figures to be positioned to face the student.

3. Exploratory Lessons

Teachers carried out a variety of exploratory lessons to spark students' geometric thinking and spatial reasoning. The following chart highlights geometry concepts and mathematical processes involved in theses lessons.

Geometry Concepts Involved	**Mathematical Processes Involved**
• Symmetry • Location and orientation • Transformation • Visualization • Composing and decomposing 2D shapes • Visual memory • Spatial reasoning • Developing spatial and geometric intuition • Identifying 3D equivalence through flips, turns, and rotations	• Reasoning and proving (spatial and numerical) • Problem solving • Reflecting • Selecting tools and strategies • Connecting • Representing • Communicating (e.g., positional language)
Exploratory Lesson	**Description**
Paper Bag Pentominoes 	During a reading of *The Paper Bag* Princess by Robert Munsch, the teacher changes the story to introduce a challenge to create 6 (of the 12) magic "keys" (pentominoes). Students came to identify and reason about how two figures can be flipped or rotated to be made to look the same.
Pentominoe Puzzles Centre 	In this activity, teachers designed puzzle outlines based on configurations of pentominoe puzzles. Two different kinds of puzzles were tried: a)one with the outline of the shapes showing, and b) the other with only the perimeter drawn. Students began to make pentominoe configurations which were then outlined to form new puzzles to challenge their classmates.
3D Cube Building Centre 	The students were shown configurations of interlocking cubes (using 3 or 4 cubes). They were asked to produce the flip versions of these configurations. Everyone closes their eyes and one student is chosen to change the orientation of the model. The small group of students in this centre then betgin to describe how the model was changed, using the language of transformations (turn, rotate, flip, etc.)

Symmetry Block Centre 	Students were provided with a half-finished design of pattern blocks and challenged to use pattern blocks to create the symmetrical image of the original.
Symmetry Lesson with Pattern Blocks  	In this lesson, *(see Appendix A)* the children will be introduced to the concept of symmetry through pattern block designs that are created on a vertical line of symmetry. The teacher does not explicitly define or explain symmetry. Rather, the students will come to understand the idea of symmetry through by participating in a game-like lesson and then through their own explorations of symmetry designs. The lesson has three distinct parts: 1. In the first part, the teacher introduces the concept of symmetry through the cutting of folded symmetrical shapes. 2. In the second part, the teacher (and a helper), work with the whole class using the large magnetic whiteboard to establish the concepts of symmetry and pattern building by modeling a paired-activity that the children will then play with a partner. 3. In the third part, pairs of students will work together using the small magnetic trays to build symmetrical designs.

5. Big Ideas in Symmetry and Location

Big Idea #1 (Marian Small, "Big Ideas from Dr. Small, K-3", p. 77):

• Locations can be described using positional language, maps, and grids.

• Positional language can be developed through games, dances, songs, etc. Children can be asked to recall the relative positions in more complex spatial arrangements. This supports the development of visual memory as students practice recalling what they have seen once it is out of view.

Big Idea #2 (Marian Small, "Big Ideas from Dr. Small, K-3", p. 77 and p.80):

• Slides and flips are transformations that change the position of a shape and possibly its orientation, but they do not change the size or shape.

• Students use transformations when creating symmetrical designs and when describing symmetry (e.g., reflections). In the early stages, students may translate the shape over the line of symmetry instead of reflecting the shape.

Big Idea #3 (Marian Small, "Big Ideas from Dr. Small, K-3", p. 77 and 82):

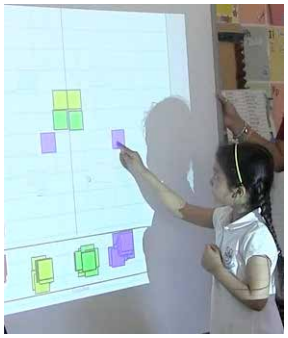
• Transformations are frequently observable in our everyday world (e.g., in nature, clothing, wallpaper, artwork, stories, maps, etc.).

• Students can be asked to describe the transformations in their everyday world.

Overview of Public Lesson
Tapping into Symmetry: A Lesson for JK/SK Students

Lesson Summary

In this lesson, students will be introduced to reflection symmetry using a grid. Students will first identify symmetrical designs on one half of a grid (divided along a vertical line of symmetry) and later will create symmetrical designs on the other half.



In Part 1 of the lesson, students will work as a whole class to identify and create symmetrical designs on a Smart Board. The lesson is designed in the spirit of a "guess my rule" game.

In Part 2 of the lesson, students will work in pairs and use metal trays marked with grids and magnetic squares to challenge each other. First, one child creates a design on one half of the grid while her/his partner makes the other half symmetrical. This game is repeated with the second student as leader. This process is repeated across multiple challenges.

In Part 3 of the lesson, children are invited to share their final patterns with others by means of a "gallery walk."

Lesson Goals:

- Support students in the identification and creation of reflection (mirror) symmetry on a grid
- Provide opportunities for students to utilize the grid to reason about spatial and symmetrical relationships
- Support students in moving from contiguous symmetry (all squares touch and emanate from line of symmetry) to non-contiguous symmetry (squares do not necessarily have to touch or emanate from line of symmetry)
- In introducing non-contiguous symmetry, students will be provided with opportunities to reasons about symmetry both spatially and numerically (e.g., "It's symmetrical because both squares are 4 squares away from the line.")
- Support students to use and understand spatial positioning language

Part I: Symmetry on The Smart Board

Students will be seated in chairs in a semicircle in front of the Smart Board. (At this point the Smart Board will be set up with a grid template and square tiles in colour piles at the bottom of the board. See picture above.) Teachers A and B introduce the idea of the Smart Board symmetry game.

Smart Board Challenge 1: Teachers model the process/game with 4 tiles

- Teacher A challenges Teacher B to make a pattern on the right side of the board that is symmetrical to the one on the left
- Teacher makes mistake in placing squares and invite children to place squares correctly
- Teachers try to elicit directional/orientation language as part of the children's proposed correction

Smart Board Challenge 2: Five-square challenge

- Same as above with more opportunities for language

Smart Board Challenge 3: squares away from the line of symmetry

- Repeat as above, but this time, Teacher A creates design where some of the squares are away from the line of symmetry (non-contiguous)

Smart Board Challenge 4/5/6: Non-symmetrical

- In this set of challenges Teacher A removes one square or adds a square to the existing pattern on the left side of the board while Teacher B and/or children hide their eyes. Upon opening their eyes, teacher and children must find the missing or added square tile(s)
- With each successive challenge there is more chance for student input

Part II: Cookie Trays And Magnetic Square Tiles (And Triangles)

Tray challenge 1: 4 tiles

- Student A will build a 4-square design on one half of the tray. Student B will close his/her eyes while Student A builds. Student B will then build the other half. A teacher sitting at the table groups will prompt students to consider how and why their patterns are symmetrical. The students' roles are reversed as the activity is repeated.

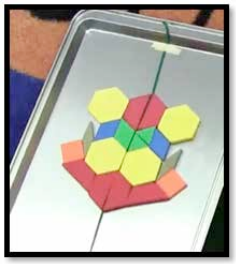
Tray challenge 2: "Floating squares"

- Building onto the previous design (from challenge 1), Student B will add an additional 4 square tiles on his/her side of the tray. The teacher will encourage Student B to experiment with including tiles that do not touch one another or emanate from the line of symmetry. Student A then creates the corresponding symmetrical half on his/her side of the tray.

Tray challenge 3: "Changing line of symmetry"

- For the third challenge, students will be encouraged to experiment with the horizontal line of symmetry. For a further challenge, teachers might wish to introduce one to three triangular tiles.

The lesson ends with a gallery walk in which students share and discuss their symmetry work.



Appendix A: Symmetry Lesson JK/SK /1

Designed by the St Andrew M4YC Group

Draft 1

Materials

For teacher

- 1 pair of Scissors
- 2 pieces of construction paper (each folded in half with a symmetrical object drawn on the half page
- Magnetic whiteboard with a vertical masking tape line through the middle
- One set of giant magnetic pattern blocks (foam)

For students

- Magnetic trays (one per pair of students) with a vertical line of yarn through the middle
- Individual baggies of magnetic pattern blocks (30 assorted pieces) (one baggie per pair of students)

Summary of Lesson:

In this lesson, the children will be introduced to the concept of symmetry through pattern block designs that are created on a vertical line of symmetry. The teacher does not explicitly define or explain symmetry. Rather, the students will come to understand the idea of symmetry through by participating in a game-like lesson and then through their own explorations of symmetry designs.

The lesson has three distinct parts:

4. In the first part, the teacher introduces the concept of symmetry through the cutting of folded symmetrical shapes.
5. In the second part, the teacher (and a helper), work with the whole class using the large magnetic whiteboard to establish the concepts of symmetry and pattern building by modeling a paired-activity that the children will then play with a partner.
6. In the third part, pairs of students will work together using the small magnetic trays to build symmetrical designs.

Learning Objectives

The students will to be able to recognize symmetrical figures and designs and will experience creating designs that employ vertical lines of symmetry.
Students will be supported to gain a basic understanding of symmetry so that they can distinguish between designs that are symmetrical and those that are not.

Students may be able to articulate their understanding of symmetry

Lesson part 1: Cutting and unfolding symmetrical paper shapes

The lesson begins with the teacher holding up a folded piece of paper on which half a heart has been drawn. The teacher asks the children what they think will happen once the shape has been cut and the paper has been unfolded. (Most children will anticipate that the unfolded cut-out shape will be a heart).

The teacher questions the children to help them express their reasoning behind their predictions. Some of the questions the teacher might ask include: 'what can you tell about the two sides of the heart?' When the teacher has heard from the children that both sides of the heart are the same, she then cuts along the line of symmetry and holds up the two halves of the heart and offers them to individual students to 'prove' that the two pieces are in fact the same.

Next, with another shape the teacher repeats the same procedure. (For example, a folded letter "A")

Lesson part 2: Introducing 'The Symmetry Game'

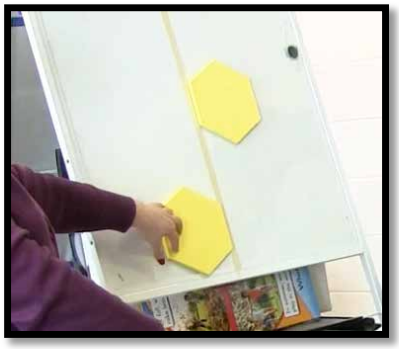
For the introduction of this part of the lesson the teacher may involve an assistant* or second teacher. (At the end of the lesson plan there is an alternative way of beginning the lesson if there is no other adult present). In this second part, the students continue to sit together on the carpet and the teacher and assistant sit beside the large magnetic whiteboard with a vertical line of symmetry drawn or taped from top to bottom. Teacher tells students that they will use the large magnetic pattern blocks to play a game, called 'The Symmetry Game'.

To begin the game the teacher takes the large magnetic hexagon and places it in the middle of the whiteboard, aligned with the symmetry line. She then hands the

assistant another large magnetic hexagon and says 'We're playing a special game, can you figure out where this hexagon should go on this magnetic board?'

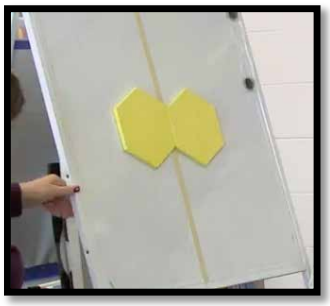
The assistant (incorrectly) places the hexagon somewhere off of the line of symmetry at the top of the board. The teacher indicates that while this may be an interesting place to put the second hexagon, for this game this placement doesn't work for this game.'

The assistant then moves the hexagon to another incorrect spot (this time, on the line of symmetry, but below the correct sport. (please see figure below)



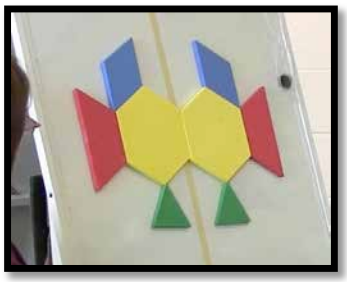
The teacher on seeing the placement says something like 'thanks for trying, but again, this doesn't work for this symmetry game'.

Teacher then invites a child to come up and place the hexagon on the board in the correct spot. (If the child has not correctly placed the hexagon so that it is touching the line of symmetry and is a reflection of the first hexagon, the teacher continues to invite students up until the correct placement is found).



Teacher then repeats the same procedure, several times, using different shapes to build a symmetrical design. For these new rounds of the game the teacher does not bother to ask the assistant but rather invites individual students to come to the board and place the patterns blocks in their appropriate space. The magnetic board guessing game ends when the teacher has used one of each shape.

Lesson part 3: Teachers Introduce 'The Symmetry Game'



In the final part, students work in pairs to play a similar game on the smaller magnetic trays.

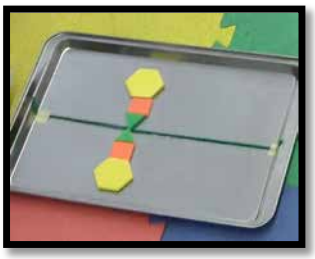
The set up for the pair game is as follows:
1. First each member of the pairs decides to be Partner # 1 or Partner # 2.
2. Partner # 1 will use one side of the magnetic tray and Partner # 2 will use the other side.

(To reinforce the idea that each student has a specific side for the full game, ask students to place their hand on their side of the tray before they begin the activity.) See figure to the right

The teacher then explains or models how the game proceeds:

The game begins when Partner #1 places a pattern block of their choice on their side of the tray so that it touches the line of symmetry. Partner #2 must then find the same pattern block and correctly position the block so that it is on the line of symmetry and is oriented as a reflection of the original.

Next, (and this part can be tricky for the children), Partner # 2 takes the lead and chooses a new block and places it somewhere on his/her side of the tray. This new block can either be touching the original block or be somewhere else along the line of symmetry. This time Partner # 1 needs to find the matching block and correctly place it on his/her side of the magnetic tray (so that is a reflection image of the other side).



This game continues for as long as students have pattern blocks in their baggies.

To conclude the game, students can hold up their tray pictures, or place along a shelf/ledge to display their work.

Before dismantling the designs the children's work can be either displayed as a class on a shelf/blackboard ledge or individual pairs can discuss their work (number of shapes used, identifying designs and images found in their work.)

**If there is no assistant, it is possible to modify the lesson so that the teacher shows the incorrect moves done by 'her friend' when she played the game earlier and then invites students to correctly place the shapes.*