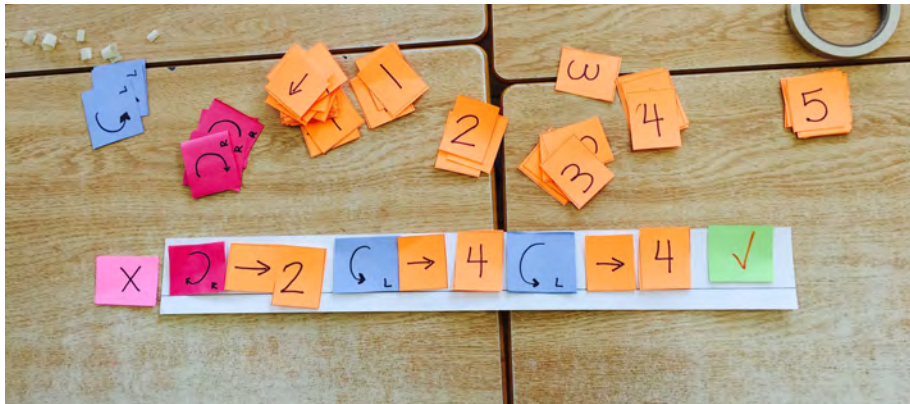


# Kawartha Pine Ridge District School Board

## Math for Young Children Lesson Study

April 21, 2015



### Focus: Visualization, Mapping and Coding

#### Research Questions:

- How does visualizing help students problem solve?
- What strategies do students use when navigating grids?
- How does coding help students visualize and problem solve?

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**Trent University:** Cathy Bruce, Tara Flynn, Mackenzie Condon, Sarah Bennett

**Discussant:** Zack Hawes, OISE

## **AGENDA**

### **11:00-3:30**

- Introductions and activity centres
- Lunch
- Background provided by the planning team
- Research Lesson
- Debrief:
  - i. Teachers who taught lesson
  - ii. Observations from teacher planning group
  - iii. Comments from guests
  - iv. Discussant: Zack Hawes

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## ACTIVITY CENTRES

It was important to our team that guests to our public research lesson have a chance to experience some of the tasks that we tried this year, as well as some resources that we discovered.

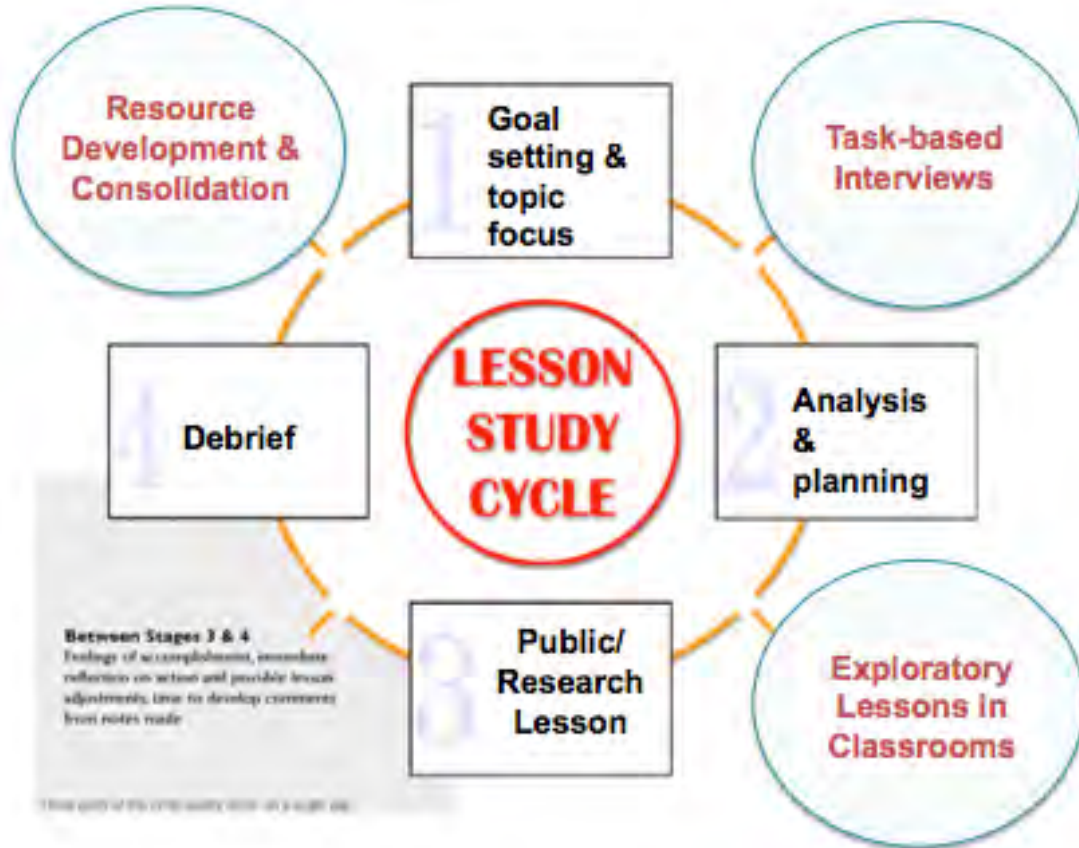
- **Technology Station:** While technology hasn't been a primary focus for our team, the team has been interested in using technology (especially iPads) in the M4YC context. When we started down the path of inquiring about coding, pathfinding and mapping with young children, things got really exciting! (Some of the resources we found on coding helped to inspire elements of today's lesson.) You will have a chance to try some games and activities on laptops or iPads, including the apps Lightbot, Flow Free and Hopscotch, the iBook for the 4-cube challenge activity, as well as the websites Johnnie's math page and coding.org.
- **Symmetry Station:** We started out our M4YC research process by trying different spatial reasoning activities, and found that the ones involving symmetry were particularly powerful and fun for children. You will get a chance to try your visualization and symmetry skills in:
  - Folding Fun Hole Punch activity
  - Symmetry Cookie Sheets
- **Congruence, Composing and Comparing:** The activities at this station are mathematically rich for both children and adult. They involve number sense, visualization, composing and decomposing in both 2-D and 3-D, mental and physical rotation, and lead to some powerful conversations about congruence. Try:
  - 3-D: 4-cube challenge
  - 2-D: Pentominos - how many different ways can you make 5?
- **Learning Carpet:** This station will be a chance to experience 3 different ideas we have been exploring – in a large, whole body kinesthetic way! Using the learning carpet as our grid, you will have a chance to explore learning activities related to:
  - Coordinates
  - Coding
  - And a favourite for kids... Battleship!
- **Coding:** As you will soon see in the public research lesson, the concepts of finding pathways, coding and mapping became an exciting branch of classroom research for us. You will have a chance to try two activities:
  - Secret code
  - The pathway game

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## BACKGROUND

This team has been working on a Mathematics for Young Children Lesson Study cycle from January to April 2015. We began our exploration with a variety of spatial reasoning tasks and decided to pursue the area of visualization, coding and mapping after rich discussion of observed student learning and thinking.

The Lesson Study Process:



Why focus on math?

- Duncan et al. (2007, 2009, 2011) identified early math skills as best predictor of school success in math, language and social studies (very large scale studies)
- Math is a better predictor of language skills than early reading is ...of later language skills!
- And math is a good predictor of overall credit accumulation (Ontario data)

Why focus on early years?

- The link between socioeconomic status (SES) and school success is well established.
- Low SES differences show up as early as age 3 (Blevin, 1996 & 2008; Lefevre et al., 2009)
- Without early intervention, children of low SES and/or with math difficulties will experience a “cascade of mathematics failure” from which it is extremely difficult to recover (Jordan & Levine, 2009).

### Why focus on spatial reasoning?

- Spatial reasoning is the ability to create and manipulate mental representations of actual and imagined shapes, objects, and structures (Cohen & Hegarty, 2012)
- We are mobile organisms living in a 3-D world: “spatial intelligence has evolutionary and adaptive importance.” (Newcombe & Frick, 2010)
- Empirical evidence indicates that spatial imagery reflects not just *general intelligence* but also the ability to solve mathematical problems, especially *non-routine problems* (e.g., Casey, Nutall & Pezaris, 2001; Wheatley et al., 1994)
- Spatial ability is a predictor of success in STEM disciplines (Science, Technology, Engineering and Mathematics) as well as the Arts (Newcombe, 2012, 2013; Wai, Lubinski & Benbow, 2009)
- Three reasons to pay attention to spatial reasoning in mathematics:
  - Spatial thinking and mathematic thinking (and achievement) are strongly related
  - Spatial thinking is malleable and can be improved through education and experience
  - Schools play an important role in fostering spatial thinking

### Challenges

- Some studies reflecting on preschool and kindergarten program amplification are showing that if curriculum in grade 1 and 2 is not also amplified, effects are lost by the end of grade 2 (Cannon, Jackowitz & Painter, 2006; Cooper et al., 2010)
- “Children do learn from play, but it appears that they can learn much more with artful guidance and challenging activities provided by their teachers” (Seo & Ginsburg, 2004)

### 5 BIG Recommendations

1. Continue to study the pedagogies involved in teaching mathematics to young children
  2. Increase the focus on mathematics in educator preparation programs
  3. Expand and refine the range of tools for measuring professional development outcomes
  4. Push the upper boundaries of mathematics curriculum for young children
  5. Advance the equity agenda, including robust implementation of researched-effective interventions
- (Moss, Bruce & Bobis, accepted)

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## CLINICAL INTERVIEWS

Selected students participated in the following one-to-one task based interviews with researchers:

- KeyMath3 (to assess number and geometry understanding)
- Magnitude test (comparing numbers to numbers; dots to dots; numbers to dots)
- 2D Mental Rotation Measure (mentally rotating two pieces of shape together)
- Visual Spatial Geometry Measure (assessment of spatial language, shape recognition and dynamic geometry)
- Peabody Vocabulary Test (to control for language)

These tasks will be repeated with the same students after the public research lesson day, to look for changes in understanding.

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## EXPLORATORY TASKS & OBSERVATIONS

### Spatial Reasoning Tasks

The teaching team explored a variety of spatial reasoning tasks. Observations by grade and task are summarized below.

#### **Task Focus: Visualization**

- Build it in your mind: *Children follow verbal instructions to mentally construct 3-D structures and select from three options to choose the correct structure.*

Grade 1	<ul style="list-style-type: none"><li>- Students really liked the game</li><li>- Focus on the visualization part of the tasks: hand gestures and covering eyes</li><li>- Students were able to eliminate which ones were wrong from the choices</li></ul>
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**Task Focus: Complexities of Symmetry, Transformation & Coordinates**

- Symmetry Cookie Sheet: *In pairs, children work on a shared metal cookie sheet with a line of symmetry drawn down the middle and take turns challenging each other to find symmetrical matches to their Pattern Block designs.*

JK	<ul style="list-style-type: none"> <li>- Students had a lot of success when building along the line of symmetry (tight-fit designs)</li> <li>- More challenging to build out from the line of symmetry (loose-fit designs)</li> <li>- Students sometimes planned their design, seeing the Gestalt (seeing the whole shape) of the image (e.g., building a rabbit or antlers)</li> </ul>
Grade 2	<ul style="list-style-type: none"> <li>- Students automatically sorted their pattern blocks</li> <li>- Students explaining to each other how a line of symmetry works – e.g., you have to look at both sides of the line and the sides have to be symmetrical</li> </ul>

- Folding Fun: *Children use their imagination to anticipate how paper that has been folded and hole-punched will look when the paper is unfolded; in particular, children are challenged to visualize and reason about how the pattern of holes will appear once the paper is opened.*

JK/SK	<ul style="list-style-type: none"> <li>- Had students close their eyes, visualize – said things like “it will be a square” when you unfold the paper</li> <li>- 7 out of 12 students visualized correctly</li> <li>- Some students predicted only one hole would be on the open paper (instead of 2), since the paper was punched only once</li> </ul>
Grade 1/2	<ul style="list-style-type: none"> <li>- Students had a lot of success</li> <li>- After discussion about the connection between folding and doubling, students could visualize much quicker</li> </ul>

- Guess the folded symmetry: *Children are presented with a shape cut out of paper that has been folded in half and are asked to reason about what shape they will see when the paper is unfolded.*

Grade 1/2	<ul style="list-style-type: none"> <li>- Challenging for students to explain attributes of the shape and use directional language</li> <li>- Seeing the Gestalt – e.g., “that looks like a butterfly”</li> <li>- When visualizing the shape after cutting it out, students were nodding their heads and using their hands</li> </ul>
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- Shape Transformer: Children are presented with the ‘shape transformer’ (a poster display board with cutout ‘input’ and ‘output’ slots). The ‘machine’ works according to a given transformation (e.g., rotates shape 45° clockwise).

Grade 1/2	<ul style="list-style-type: none"> <li>- Students gesturing reflection by flipping their hands</li> <li>- Students spent time discussing what was happening</li> </ul>
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**Task Focus: Mapping, Location, Orientation and Gestalt**

- Barrier Game: Children play a game where one student is the designer and the other is the builder, with a barrier between them. The designer describes his or her design to the builder.

Grade 1	<ul style="list-style-type: none"> <li>- Required a lot of teacher prompting and modeling</li> <li>- A lot of students seeing the whole picture/Gestalt (e.g., cat)</li> <li>- Lots of vocabulary – (e.g., stacking, building, horizontal lines, vertical lines)</li> <li>- Tight together shapes were easier for students</li> </ul>
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**Task Focus: Exploring Composing and Decomposing and 2-D and 3-D figures**

- Fill It! (Tangrams task): Children are given the outline of a design to fill in (with Pattern Blocks or tangrams). Each design can be solved in two or three different ways.

JK/SK	<ul style="list-style-type: none"> <li>- Surprised by student vocabulary (using proper terminology for shapes)</li> <li>- Some students building beside the paper</li> <li>- Recognizing “oh two trapezoids can make a hexagon”</li> <li>- Led to exploration of composing hexagons in as many different ways as possible (e.g., 2 trapezoids, 3 rhombi, 6 triangles; 3 triangles and a trapezoid)</li> <li>- Able to replace shapes with other shapes (i.e., composing and decomposing to work with the shapes available)</li> </ul>
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# **Exploratory Tasks Set I**

## **FOCUS: Pathways (Direction, orientation and location)**

### **Goals:**

- Visualize, verbalize, verify
- Exploring the location and orientation of: shapes (e.g., transformations), pathways (navigating through along a path), the body (physical/embodied movement)
- Develop student vocabulary around orientation, location, transformations

### **Task I – Physical 10-frame pathway**

#### *Materials/preparation:*

- Large 10-frame taped on carpet/floor
- 1 green and 1 red piece of construction paper to mark the start and finish of the path
- Obstacles (e.g., objects from around the room)
- Decide on a set of “rules” (e.g., can only give directions for one square move at a time, can’t move on the diagonal)
- Smart Board to record different pathways and/or laminated 10-frame to record with dry erase

#### *Scenario:*

- We need to help Student A/Teacher A get from the green piece of construction paper to the red piece of construction paper. They need us to give them directions on the pathway they should take
- Could have either whole class giving directions to either a teacher or a pair of students OR have a pair of students work together, taking turns directing each other through the maze
- Try a couple of different starting/ending points
- Introduce obstacles which students have to navigate around

#### *Anticipated responses:*

- Students might not use precise language (e.g., walk straight, move, go to the end, etc.)
- Students might visualize/plan out an entire pathway, or see it step-by-step

#### *Key prompts/language:*

- Encourage students to use specific terms (e.g., move to the square “in front of”, towards landmark (e.g., the wall, an object, etc.), move left, right, north, south, east, west (could encourage/support this with signs placed on the floor in the appropriate direction, e.g, left, right)

#### *Possible extensions/variations*

- Students could track the different pathways (e.g., on paper, using Smart Board): how many different pathways can you come up with?

## Task 2 – 4x4 grid pathway

*Materials/preparation:*

- 4x4 grid
- Indicate start and finish

*Sequence:* model one path, then partners take turns giving and receiving instructions to form a pathway

**Part 1 (Simple pathway)** – Partner A tells Partner B how to get from the start to the end. Switch roles and repeat, but making a different pathway (sit beside your partner, facing the sheet together).



**Part 2 (Pathway with obstacles)** – Add one obstacle, and find two pathways (Partner A tells Partner B and vice versa). Next try adding two obstacles and do the task together.



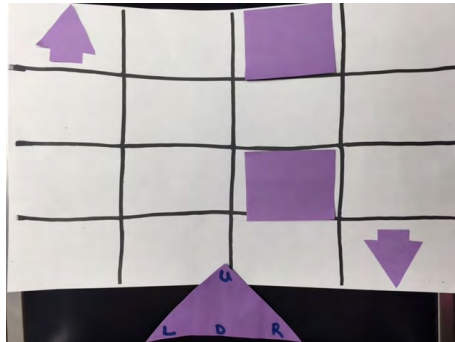
**Part 3 (Arrow pathway)** – Move the arrow from the starting position and orientation to the final position and orientation. (Partner A gives directions, Partner B follows instructions, and vice versa.)

*Anticipated responses:*

- Students may find initial challenges with communicating instructions or understanding instructions.
- When additional, more precise language is modeled or introduced (e.g., transformational, directional and/or positional language – see below), students may incorporate more in their instructions, making the task of giving and receiving directions easier

*Key prompts/language:*

- Observe listen for language and model/introduce if students are not using it.
  - language of transformational geometry (slide, flip/reflect or rotate/turn) – especially in arrow pathway task
  - directional language (e.g., left, right, up, down)
  - positional language (e.g., above, below, on top of, underneath)
- If students aren't using these terms, introduce them or simply model their use (e.g., "I see you are rotating the arrow clockwise/to the right.")
- Consider including a "direction key" showing up, down, left and right to remind students of directional terms.



**Observations: Task Set 1**

<b>JK/SK</b>	<b>Grade 1</b>	<b>Grade 2</b>
<ul style="list-style-type: none"> <li>- Using 10-frame (large mat on carpet), the Smart Board, or individual mats</li> <li>- Students in one class were never moving to the right; always moving to the left (wondered if they were understanding the directions)</li> <li>- Using physical/colour anchors to indicate direction (e.g., "move the purple way")</li> <li>- Introduced barriers that students had to navigate around</li> <li>- Students (JK) able to remember their original paths (visualizing pathways)</li> </ul>	<ul style="list-style-type: none"> <li>- Put two shapes together (grade 1/2)</li> <li>- Some students completely understanding left and right</li> <li>- Very confident navigating 10-frame, but not as confident with a 4x4 grid</li> <li>- Liked challenge of finding longest/shortest path (discussion about number of squares travelled vs. number of moves/directions)</li> <li>- Saying "Move 4 over east"</li> </ul>	<ul style="list-style-type: none"> <li>- Used hundreds chart with numbers on it</li> <li>- Direction aid (triangle with up, down, right and left written) was very helpful</li> <li>- Some student would say "move right to 37"</li> <li>- Interested in giving students a blank grid to see what they would do</li> </ul>

## **Exploratory Task Set 2A**

### **From Secret Codes to Coordinates – A Three-Task Progression**

*Note: All grids should be drawn on a blank piece of paper (i.e., not lined or graph paper). You can use varying grid sizes (e.g., 4x4, 5x5 or 10x10) depending on the level of challenge you want to provide. 4x4 and 5x5 grid templates have been sent as email attachments.*

#### **Task I – Secret Code Game**

*No coordinate labels on grids*

E.g., **X** (starting point)

↑ 2

→ 3

↓ 1

✓ (end point)

#### Materials:

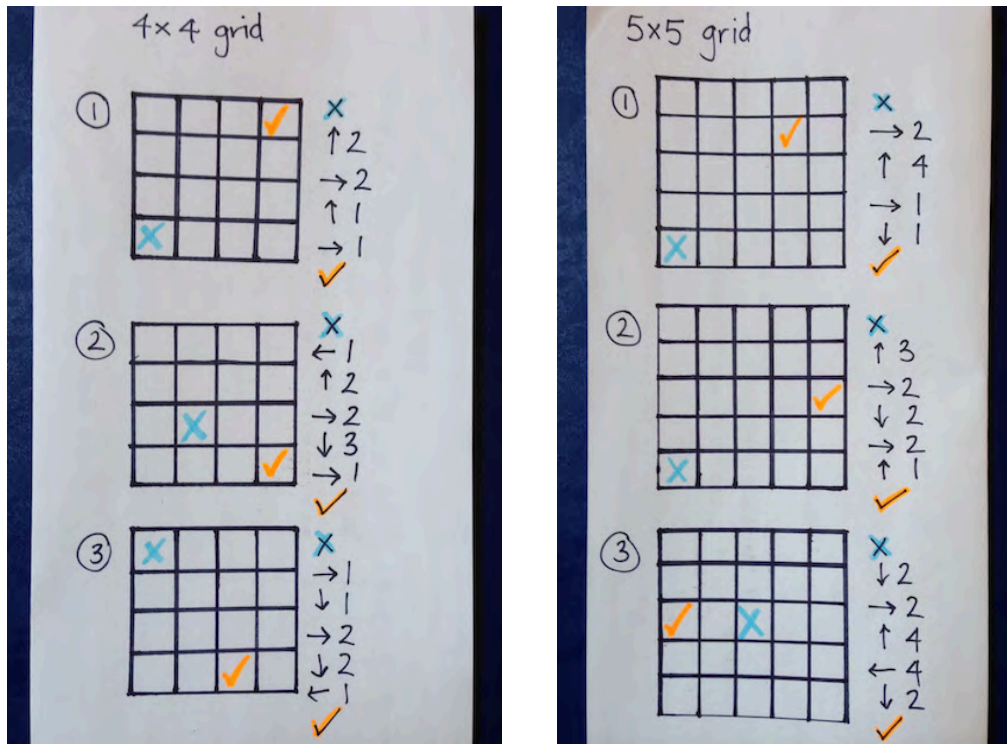
- 4x4 and 5x5 grids with start (**X**) and end (✓) points marked
- Secret codes, written vertically, with symbol before number on a separate piece of paper
- Solution pages (see photos at the end of Lesson 1)

#### Lesson Overview:

1. Model 3x3 grid (as an introduction, if needed)
2. Students could work together in pairs or individually
3. Start with 4x4 (series of 3 codes)  
E.g., Two codes starting in bottom left corner of the grid and a third code starting in a different location. Codes should have a different number of steps (see “4x4 grid” photo below for examples)
4. Then introduce 5x5  
E.g., Two codes starting in bottom left corner of the grid and a third code starting in a different location. Codes should have a different number of steps (see “5x5 grid” photo below for examples)
5. Instructions to students for playing the *Secret Code Game*:
  - a. Here is your grid
  - b. Here is your secret code
  - c. *Visualize* – where do you think the end check mark will be? Encourage students to do this without counting squares along the grid
  - d. *Verbalize* – discuss with partner
  - e. *Verify* – draw pathway with a marker
6. Option to have students document the steps along pathway (e.g., write ↑ 2 beside the line moving up two squares)

7. Extension: have students create their own secret code pathways for a partner

Example solutions and secret codes:



Points of Observation:

- Language: Are students using positional words?
- Visualization: How are students visualizing? Do they become more accurate at visualizing the end point with practice?
- Gesturing: Do students gesture? How are they gesturing? When do they gesture?

**Task 2 – Finding Hidden Treasure, “Battleship-style”**  
**Introducing coordinates**



### Materials:

- 4x4, 5x5 or 10x10 grids with coordinates
- Objects to cover squares, that cover either one square, two, or multiple squares completely (e.g., pieces of coloured cardstock)
- Physical barrier (for placing between students)

### Lesson Overview:

1. Working in partners, one student hides the treasure and one guesses its location. This could be set up as a barrier game with a physical barrier placed between students sitting side-by-side (to ensure they are taking the same perspective of the grid for giving/receiving directions)
2. Partner A: I've hidden treasure at a secret location (object placed somewhere in grid, taking up one square to begin)
3. Partner B: Guesses where the treasure Students sitting side-by-side (to take the same perspective)
4. Treasure gets bigger: could be a rectangle (i.e., covering two spaces) – need to identify both squares). Once Partner B has located the first square, guessing the second square requires students to visualize options of where the second square could be (either to the left or the right, above or below)
5. Treasure gets even bigger! Could move to an object that takes up three squares

### Points of Observation:

- Language: Are students using positional words? How successful is Partner B in guessing the location of Partner A's treasure? What does Partner A do to help Partner B find their treasure?
- Visualization: How are students visualizing? What evidence do you have?
- Gesturing: Do students gesture? How are they gesturing? When do they gesture?

## **Task 3 – “Take a Path”, mapping Exploring coordinates**

### Materials:

- 4x4, 5x5 or 10x10 grid
- Objects to place on the grid (e.g., a house, park, school)

### Lesson Overview:

1. In pairs, students are given a grid with objects to place on certain squares (e.g., a house, park, school)
2. Take a pathway between objects on the grid (e.g., between the house and the park): Partner A visualizes and verifies a possible pathway and describes it to Partner B
  - a. Variation 1: take a path from A to B
  - b. Variation 2: take a path from A to B to C
  - c. Variation 3: take a path from A to B to C to D

3. Rules for giving pathway directions (set parameters, increasing in challenge):  
*Students should use directional words such as up, down, forward, backward, N, S, E, W, left/right*
  - a. One square (move from A1, up to B1, up to C1)
  - b. Multi-squares (move up to C1)
  - c. Show two ways to get from A to B, shortest path, longest path

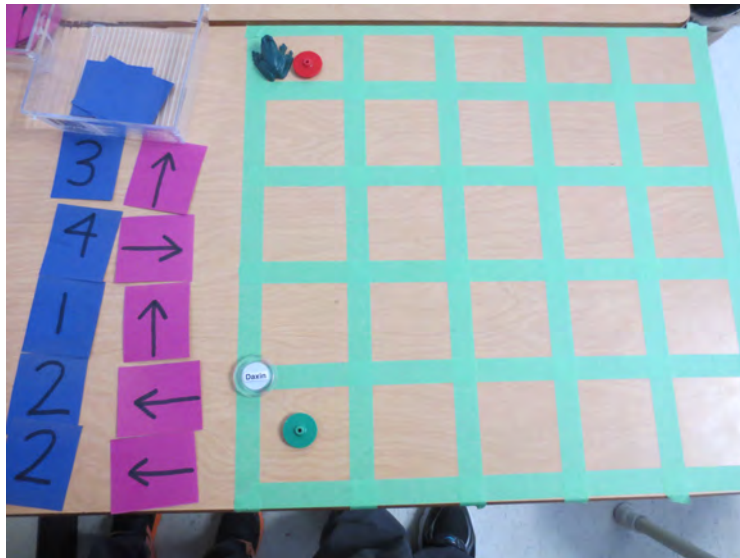
Points of Observation:

- Language: Are students using positional words? How successful is Partner A in describing their pathway to Partner B? What does Partner A do to help Partner B if they are struggling?
- Visualization: How are students visualizing the pathway? What evidence do you have?
- Gesturing: Do students gesture? How are they gesturing? When do they gesture?

## **Exploratory Task Set 2B** **Pathway Coding Game**

Materials:

- Grid of any size (we used 4x5 but you may wish to vary size with difficulty level)
- Markers to indicate Start and End points on grid
- Figurine to move around grid
- Set of individual number cards (labeled 1, 2, 3, 4 etc., as needed) and arrow cards
- Writing utensil (optional, if student wishes to draw their pathway)



### Lesson Overview:

*You may wish to first demonstrate a round of the game for students to see*

1. Student work together in partners
2. One student is the “code-maker” and one is the “code-checker”
  - a. Code-checker turns back or hides eyes so they can’t see grid
  - b. Code-maker chooses Start and End points on grid, and marks these with provided indicators
3. Code-maker then begins choosing a path for which to move their figurine from Start to End. They will mark each step of their pathway code using the provided number and arrow cards. A completed pathway code could look something like this:  
4 → 3 ↑ 2 ← 2 ↓ 3 → 1 ↑
4. When the code-maker has completed their pathway code, the code-checker can now turn around/uncover eyes
5. The code-checker will now follow, or “check”, their partners pathway code to see if they arrive at the same End point
6. When completed, partners may switch roles and create a new pathway code

### Possible Variations/Extensions:

- Use a larger grid for added difficulty
- Add diagonal directional arrows
- Add barriers on grid that students must navigate around
- Add turns (e.g., ½ turns, full turns, etc.)
- Use cardinal directions NSEW instead of arrows
- Make it into a treasure hunt or treasure map
- After one student makes a pathway code, ask the other student to create a shorter code to the same endpoint, or a longer code, or a code with exactly 6 moves, etc.
- Code-maker reads their code aloud to their partner, instead of the code-checker reading it themselves off the cards
- Emphasize “Visualize, Verbalize, Verify”

### Points of Observation:

- Language: Are students using positional words?
- Visualization: Are students visualizing the pathway ahead of time? Are code-makers moving figurine along with each step of the code, or visualizing multiple steps at once?
- Gesturing: Do students gesture? How are they gesturing? When do they gesture?



**Observations: Tasks 2A & 2B**

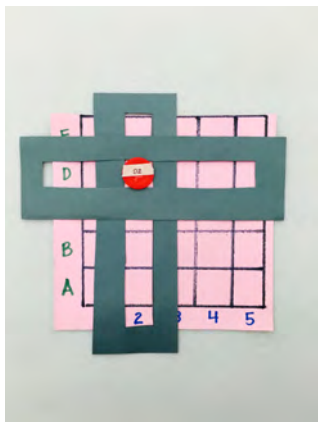
<b>JK/SK</b>	<b>Grade 1</b>	<b>Grade 2</b>
<ul style="list-style-type: none"> <li>- Whole group lesson: starting at checkmark, given code</li> <li>- Some students using fingers to navigate</li> <li>- Using left/right, up/down</li> <li>- In pairs at easel (5x5 grid) placing and naming coordinates (JK)</li> <li>- Working at easel, one student created code and the other had to follow the code</li> <li>- Started following the code and then had to pick up friend on the way</li> <li>- Hard for students to avoid counting the square they were in</li> <li>- Could label pictures by grid coordinates</li> </ul>	<ul style="list-style-type: none"> <li>- Visualizing, verbalizing, and verifying when doing the “Secret Code”</li> </ul> <p>Grade 1/2:</p> <ul style="list-style-type: none"> <li>- Used 100s chart</li> <li>- Students need directional anchors (e.g., move towards the yellow square)</li> <li>- With grade 8 buddies, students doing simple computer coding &amp; programming</li> <li>- Tricky to take the perspective of someone else (orientation discussion)</li> </ul>	<ul style="list-style-type: none"> <li>- Student made their own secret codes on 4x4 and 5x5 grids</li> <li>- Did a lot of talking about words that describe movement</li> <li>- Discussed grids and where grids are in our world (e.g., GPS, globes)</li> <li>- Next step: coordinates</li> </ul>

## **Exploratory Task Set 3A** **Exploring Coordinates and Bird Battle**

*Note: All grids should be drawn on a blank piece of paper (i.e., not lined or graph paper). You can use varying grid sizes (e.g., 4x4, 5x5 or 10x10) depending on the level of challenge you want to provide. 5x5 grid templates have been included. If you want to use poker chips for each coordinate square in the grid, be sure the grid is large enough to fit the poker chips. 4cm x 4cm per square is ideal for standard poker chips.*

### Materials:

- 5x5 Grid (you may wish to vary size with difficulty level). Coordinates labeled with letters along left side of grid, and numbers along the bottom
- 25 cards, per player, with coordinates on them (A1, A2, etc.). You may also wish to use labeled poker chips, or similar.
- 2 “windows” which can be placed over the grid to highlight an entire row or column
- Line Masters are at the end of this task write-up



### Task Overview:

*May be used as full class, small group, or individual lesson. Note: 5 variations of the task are listed below as a progression, but it is not necessary to complete all in the same lesson or day.*

5 progressions of the task are as follows:

1. Explain to students that today we are going to work with coordinates on a grid! Use the windows to show the entire row labeled as “A”, the entire column labeled as “1” etc.  
Have cards in an ordered pile beside grid. Explain to students that each card or poker chip has its own special square on the grid. Begin by working with the student(s) to place the first card, A1, with the intention of working towards students being able to place all cards on their own.  
*Note: If students are struggling to understand placement of cards, use windows to highlight the row and column of a given card. Ex. For card D3, highlight row D and column 3, and place the card where the two windows cross.*

2. Say to student, "I'm going to take away or turn over a few cards, while they're still laid out on grid, so you have to pay attention! Tell me which cards are missing."
3. Shuffle the cards/poker chips in a bag so they're no longer in order, and ask students to randomly select out of the bag and place them on the grid once again.
4. Now let's see what students can do without the cards.
  - i) Leave only 3 cards on the grid, and hand student a 4<sup>th</sup>. Where does this card go?  
*Note: This is an example of **Receptive Communication***
  - ii) Leaving only 3 cards on the grid, and place another flipped upside down on the grid. Which card is this?  
*Note: This is an example of **Expressive Communication***
5. Bird Battle! We are now going to add the concept of orientation, and not simply location. Place a small figurine (does not need to be a bird, just something that can be easily seen to be facing in one direction) on a square, and have students explore the idea of *location and orientation*. For example, "the bird is on B2, facing left". When students are comfortable with this, you can turn it into a Battleship-type game and have students work in partners. You may wish to vary the number of birds on each student's grid, or add figurines that cover more than one square (similar to the larger ships in Battleship).  
*Note: If students are not strong with left and right, you may wish to use landmarks instead for orientation. "The bird is on C3, facing the purple star". You could also try using the compass directions of North, South, East and West.*

Language to Use: Row, Column, Coordinates, Location, Orientation, left, right, facing, toward, intersection, coordinate square

Points of Observation:

- Language: Are students using appropriate wording to indicate location and orientation?
- Visualization: Are students able to visualize and have an awareness of the various rows or columns? For example, if a student chooses the card E3 and instinctively moves their hand towards the top of the grid, even before knowing the exact square in which it should be placed.
- How quickly do the students integrate the concept of rows and columns that generate coordinates into their work?

## Exploratory Task Set 3B Visualization, Mapping and Coding

Goal: encourage student visualization, practice giving direction and coding  
*Students visualize a path, follow it, and then direct a friend through the navigation of their visualized path; a process of visualizing, verbalizing and verifying*

### Materials:

- Direction buddy (with nose and paws, labeled L and R)
- “walkable” 5x5 grid (e.g., masking tape on carpet)
- Markers for path: **x** for start; **✓** for end
- Cards for recording (arrows, numbers 1-5, left turn, right turn)



### Task Overview:

Minds on: every one facing the same direction, practice turning and walking  
(E.g., turn to the right and take two steps)

Language: turn, right, left, forward

### Talk Aloud/modeling:

- There are going to be 3 jobs: someone making the pathway, a partner, a recorder
- Introduce the duck – beak/feet pointing forward, L and R on wings
- I’m going to visualize where I want my ending spot to be. Got it. Have to remember that my first move has to be a turn unless I’m going forward. **TURN TO THE LEFT [HOP].** I used my little ducky to help [remind children of their helper]. **GO FORWARD 2.** One, two. **TURN TO THE RIGHT.** **GO FORWARD 3.** One, two, three. **TURN TO THE RIGHT.** **GO FORWARD 4.**
- At one point say, “now where was my end spot again?” To reinforce the visualizing of end point
  
- Now I’m going to direct my partner (standing facing the same direction as partner, outside of grid)

- For first move, don't leave that square, don't move until I give you a direction. TURN TO THE LEFT. GO FORWARD 2 STEPS. TURN TO THE RIGHT. NOW YOU ARE GOING TO GO FORWARD 3 STEPS. TURN TO THE RIGHT. GO FORWARD 4 STEPS.
- NOTE: *The partner giving the directions can turn on the spot when instructing partner to turn.*
- Model the change switch in partner roles (run through whole process again)

#### Group of 3 students

Student A – path maker (talking-aloud)

Student B – path taker (led by Student A who is visualizing the path)

Student C – path recorder\* (to aid in verification at the end, recording while Student A is talking)

\*path can be recorded using cards (numbers, arrows, L and R turn cards, see photo above)

- Student A takes time to visualize their path. Option to have Student A mark their end point on a paper grid and/or tell a friend
- Once a path has been planned, Student A places the starting card (x) somewhere inside a square on the top row of the grid and begins to talk aloud as they follow their path (e.g., Turn to the right. Take two steps forward)
- While they are taking their path, Student B is watching and Student C is recording the code
- Place an ✓ once path is done.

#### Reminders:

- Don't count space standing in as a square
- Give directional/turn instructions as a separate step from number of squares (e.g. turn left, move two steps, turn right). Might need to prompt students to slow down/break steps up

#### Other points of consideration:

- If students forget, they can ask the recorder what the next move was, or confirm the move was correct
- Rotate through positions A, B and C so that each student has a chance to try each role.

Follow-up: using a recorded code, read aloud and follow the code to verify pathway again (This can be done on the carpet grid or on a grid on paper using a pencil)

#### Points of Observation:

- Language: Are students using appropriate wording to indicate location and orientation?
- Visualization: Are students able to visualize their path, keep the pathway in their mind, follow it and then describe it to a friend
- Ask students which role they found the easiest/most challenging and why

## Observations: Tasks 3A and 3B

JK/SK	Grade 1	Grade 2
<ul style="list-style-type: none"> <li>- Working on coordinates – showing row and column intersection using windows/strips of paper was very important and helpful</li> <li>- After taking the strips away, students more successful with placing objects on grid coordinates</li> <li>- Sometimes placing object on A1 instead of A3 (identifying row, but not column, or vice versa)</li> <li>- Lots of talk about rows and columns</li> <li>- Loved playing “Hidden Ships” (on 5x5 – A-E; 1-5 grid)</li> <li>- Walking the grid was fun and helpful – e.g., starting at B, walking over to 3 (B3)</li> <li>- Placing a tile on a specific coordinate was easier than naming a coordinate without the tile</li> <li>- JKs ready for simple Battleship game (A-E; 1-5 grid)</li> </ul>	<ul style="list-style-type: none"> <li>- 5x5 grid for coordinates on the carpet – easy for students</li> <li>- Used directional buddy – very helpful with orientation and directions</li> </ul> <p>Grade 1/2:</p> <ul style="list-style-type: none"> <li>- Did Bingo-type game on grids – students really enjoyed it</li> <li>- Played “Battlebug” – very accurate “squishing” bugs</li> <li>- Turned it into a barrier game with partners, giving directions and verifying locations at the end</li> </ul>	<ul style="list-style-type: none"> <li>- Duck (directional buddy) visualization – students found being the recorder was hardest</li> <li>- Students able to visualize as they watched their friends and created quite long paths</li> <li>- Use grids to start on coordinates – lots of success</li> <li>- Lots of fun playing Battleship</li> </ul>

### A FOCUS ON CODING

A code is a step-by-step procedure that can be very simple or very complex. Coding is often associated with computer commands and programming. The team decided to explore coding as we viewed it as a great way for students to explore a variety of mathematical thinking, including: organization; being able to read space, measure distance, categorize, and group things together; recording data; and counting on. Working with simple codes provides students with the opportunity to develop a foundation for much more complex thinking.

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# RESEARCH LESSON

## Treasure Map (Brief Overview)

Led by Jean Ann and Juli, “coder buddies” are Bacall, Val, Deb, Laurie

### Big Ideas

- Translating between pathways, codes, and maps
- Comparing lengths of pathways (number of squares) as opposed to codes
- Use the 3 V’s (Visualize-consideration of possible pathways home, Verbalize-directions for pathways and code, Verify-check code against a map/carpet)

**GOAL:** Students will visualize, verbalize and verify different coding and mapping options on a grid while paying attention to orientation details.

### Materials

- 10x10 grid labeled with letters on x-axis, numbers on y-axis (4 with secret pathway already marked, 4 blank)
- 3-D Pirate/Person Figurines, with L & R indicated on hands (1 per student=12 total)
- Gold coins, marked with (3 per group=12 total)
- Coding strip (1 per group=4 total); tape for sticking codes to coding strip
- Coding cards (with directional arrows, arrows to indicate turning, numbers, and “COIN”)
- Smart Board with secret pathway grid displayed
- Option to have treasure chests, purse for gold coins

### Lesson Overview

\*\*To be done in 4 groups of 3 students each; 12 students total

### Set-Up

- 1) 3 students per group: Direction giver, Pirate, Coder (Note: “coder buddies” will work with Coder to assist if necessary)
- 2) Direction giver and Pirate side-by-side, Coder can be apart
- 3) Direction giver has secret map with pathway already drawn, and 3-D figure  
Pirate has blank map, and 3-D figure  
Coder has coding strip and coding cards

### Task

- 1) Direction giver will follow their map and read directions to Pirate
- 2) Pirate will follow instructions to move their figurine along the path to 1<sup>st</sup> coin. When they think they’ve reached the correct square, they must say the coordinates of the square to get the coin. Coordinate will be written on coin so they can verify they are correct. If incorrect, must try again.
- 3) Repeat for coins 2 and 3, and continue until Big Treasure!
- 4) When they have found the treasure, the coder (or all) can *verify* code with the secret map, moving their figurine to follow the code and ensuring it matches the secret pathway

## Consolidation

- 1) Students all come together on carpet as group
- 2) *Verify* that each group had the same code
- 3) Now that we found treasure, we need to get home fast! Everyone take a minute to *visualize* different pathways we can take to get home. Can anyone think of a path to get home with the least number of footsteps/squares? [Ideally, we will get the 2 obvious pathways along the outside, plus one down the middle with a staircase. We can introduce options if students are stuck]
- 4) Draw the suggested paths on Smart Board with different coloured markers. Mark pathways in “dot-to-dot” format, so it’s easy to count squares.
- 5) If students seem capable, we can now ask them to compare the codes of each path; although they may be an equal number of squares in length, which codes are longer and which shorter?

## Notes

- Students will require minimal interference from “coder buddies” (and no interference from observers). “Coder buddies” will assist coders in keeping up with coding, and otherwise only if students are way off track.
- There were worries about what to do if code does not get recorded correctly: Students should be self-checking with coins (they only receive the coin if they correctly name the coordinates of the coin square). If they get way off track, teacher helper can assist.
- We don’t need to define “shortest pathway” beforehand. Instead, we can later use this as a discussion point with students when comparing first the number of squares used, then length of code.

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## OBSERVATION GUIDES

1. Visualization
  - a. Are students gesturing (hand movements, eye movements, full body movements)?
  - b. What evidence do you have?
2. Directional Language
  - a. What directional language (e.g., forward, backwards, turns, left, right, up, down) are students using?
  - b. Do they use directional scaffolding (e.g., a “directional buddy”)? Do students use coordinates as markers?
3. Student Interactions
  - a. How do students collaborate/share responsibility/take on roles?
  - b. How do students deal with frustration?
  - c. Overall engagement with the task
4. Visualizing, mapping and coding
  - a. Are students noticing and recording each separate movement?
  - b. Are students chunking movements together (e.g., move 5 squares)
  - c. How does the coin help students?
  - d. How are students using the coordinates?

### Whole-group Observations:

- What is quickest way home? (E.g., number of squares travelled vs. number of codes/directions in pathway)
- What comparisons are students making in terms of length of path and number of squares?
- How are students leveraging their number sense when talking about coding?
- Are students composing and decomposing numbers? If so, how?



## **OBSERVATION GUIDE I: Visualization**

1. Are students gesturing (hand movements, eye movements, full body movements)?
2. What evidence do you have?

### Whole-group Observations:

- What is quickest way home? (E.g., number of squares travelled vs. number of codes/directions in pathway)
- What comparisons are students making in terms of length of path and number of squares?
- How are students leveraging their number sense when talking about coding?
- Are students composing and decomposing numbers? If so, how?

## **OBSERVATION GUIDE 2: Directional Language**

1. What directional language (e.g., forward, backwards, turns, left, right, up, down) are students using?
2. Do they use directional scaffolding (e.g., a “directional buddy”)? Do students use coordinates as markers?

### Whole-group Observations:

- What is quickest way home? (E.g., number of squares travelled vs. number of codes/directions in pathway)
- What comparisons are students making in terms of length of path and number of squares?
- How are students leveraging their number sense when talking about coding?
- Are students composing and decomposing numbers? If so, how?

### **OBSERVATION GUIDE 3: Student Interactions**

1. How do students collaborate/share responsibility/take on roles?
2. How do students deal with frustration?
3. Overall engagement with the task

#### Whole-group Observations:

- What is quickest way home? (E.g., number of squares travelled vs. number of codes/directions in pathway)
- What comparisons are students making in terms of length of path and number of squares?
- How are students leveraging their number sense when talking about coding?
- Are students composing and decomposing numbers? If so, how?

## **OBSERVATION GUIDE 4: Visualizing, mapping and coding**

1. Are students noticing and recording each separate movement?
2. Are students chunking movements together (e.g., move 5 squares)
3. How does the coin help students?
4. How were students using the coordinates?

### Whole-group Observations:

- What is quickest way home? (E.g., number of squares travelled vs. number of codes/directions in pathway)
- What comparisons are students making in terms of length of path and number of squares?
- How are students leveraging their number sense when talking about coding?
- Are students composing and decomposing numbers? If so, how?