Please take some time to **PLAY**! Engage with a question and the materials.
Acknowledgement

Before going any further, it is important that we recognize that we are here today to learn on the unceded, shared territories of the Coast Salish people on which our schools are located. We recognize that the Katzie and Semiahmoo First Nations who have signed the Surrey Schools Aboriginal Education Enhancement Agreement.
Playful Mathematical Inquiry in Grades 3 to 5: Multiplication

February 16th, 2017 ~ STA Focus Day
North Surrey Secondary School
Presented by Jen Barker
Twitter: @barkerJBarker
Acknowledgements

• Thanks to Cynthia Walker, Gurpreet Koonar, Diane Brebeck, Hyekyung Lee for letting me try out some lessons in their classes!

• These ideas have been collected and/or inspired from a number of sources. Please see hand out for specifics!
Learning Intentions

• I have an emerging definition of PLAY!

• I understand there are different types of inquiry and what these look like.

• I understand my role as the teacher during playful mathematical inquiry, including designing the learning opportunities, asking nudging questions, and providing formative and summative assessment.

• I have a few ideas about how to design and incorporate playful Mathematical inquiry in my math class with regard to multiplication.
Where can you find PPT, learning intentions, and more ideas?

www.meaningfulmathmoments.com

Click the Presentations tab and look for STA Focus Day
What grade do you teach? Why did you sign up for this session?
PLAY

Diminished consciousness of self
- no good or bad
- willingness to take risks

Improvisational Potential
- its openness
- co-constructing understanding

Continuation Desire
- it hooks! Focused attention
- self motivated
What is Inquiry-based learning?

Inquiry-based Learning is a dynamic and emergent process that builds on students’ natural curiosity about the world in which they live.

As its name suggests, Inquiry places students’ questions and ideas, rather than solely those of the teacher, at the centre of the learning experience. Students’ questions drive the learning process forward.

Teachers using an inquiry-based approach encourage students to ask and genuinely investigate their own questions about the world. Teachers further facilitate students’ learning by providing a variety of tools, resources, and experiences that enable learners to investigate, reflect, and rigorously discuss potential solutions to their own questions about a topic the class is studying.
<table>
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<td>How to know</td>
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<td>Tell and memorize</td>
<td>Ask and inquire</td>
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<td>Only one right answer</td>
<td>Many conclusions</td>
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<td>Teacher-directed</td>
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<td>Active learning</td>
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<td>Assess for marks</td>
<td>Assess for learning</td>
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Shifting Pedagogical Paradigms

Thinq 4 - 6: Inquiry based learning in the junior classroom (2016), p 12
Types of Inquiry

Structured Inquiry:
- The teacher determines the big idea and what the students will come to understand by the end.
- The teacher starts with the guiding question.
- The students help create the plan and guide the inquiry with their questions, interests, ideas, analysis, reflections and understandings.

Guided Inquiry:
- The teacher comes up with the big idea or topic and or the teacher come up with the questions.
- The students are responsible for designing and following their own procedures to test the question and then communicate their results and findings.
Open Inquiry:
- The students determine the purpose and formulate the questions.
- The students design procedures, gather the materials and communicate their findings.
- The teacher facilitates, supports, asks questions and redirects the investigation.

From Michelle Hikida, Richmond Teacher
What might this look like in my classroom?

Whole class structured inquiry
- everyone has the same question & the same materials

Whole class guided inquiry
- everyone has same question and choses from the different materials at each table

Small groups guided inquiry
- Different questions and different materials at each table
- could have 2, 3, or 4 questions around the class

Individual or Partner Open Inquiry
- Lots of different questions
- Many different materials dependent on what students choose
Structure of a Whole Class Lesson

1. Introduce the problem - use a book, image, artifact

2. Exploration Time - what materials will you need?

3. Sharing - what strategies did you try?
Developmental progression of Multiplication

- Recognizing Equal Groups
- Multiplying Equal Groups - skip counting & repeated addition & groups of
- Multiplying Using Rectangular Arrays
- Using Multiplicative Thinking to Solve Single & Multi-digit questions including language such as times, twice as many, etc.
  - Using known facts and compensating
  - Doubling and Halving
  - Using the commutative property
  - Using the distributive property
  - Using the associative property
Finding Out What Students Know
Activating Prior Knowledge

What are all the ways you can show $8 \times 7 = \underline{\hspace{2cm}}$
AFTER: Students share aloud the strategies they know!

- **Strategies for Multiplication**
  - Groups of Model or Picture
  - Skip Counting: 8, 16, 24, 32, 40, 48, 56
  - Array
  - Related Facts
    - 56 ÷ 7 = 8
    - 56 ÷ 8 = 7

- **Using Facts I know/Friendly Facts**
  - 8 × 7 = 56
  - 8 × 8 = 64
    - 64 ÷ 8 = 8
  - half of 8 is → 4 × 7 = 28 and 28 + 28 = 56
  - half of 8 is 4, half of 4 is 2, so 8 = 2 × 2 × 2
    - 56 ÷ 2 = 28
    - 28 ÷ 2 = 14
    - 14 ÷ 2 = 7

- **Commutative Principle**
  - 8 × 7 = 56
  - 7 × 8 = 56
  - Factors can be rearranged and the product is the same.
How could teachers use this information to inform their instruction?

How might you plan your Multiplication unit?
Designing learning opportunities that are PLAYFUL & ENGAGING?

- Exciting literature
- Inviting Materials
- Connected to students’ interests
- Multi-modal - hands on, kinesthetic, visual, auditory
- Opportunities for Collaboration
- Organized
Lessons that provided an entry point for all and allow each student to work to their potential.

Learning Intentions for:

- **ALL**
- **SOME**
- **FEW**

Thanks to Shelley Moore for her work in this area.
How do we assist students in seeing equal groups?

- Counts by equal groups (e.g., 2’s, 5’s, 10’s, and so forth)
- Knows the quantity stays the same when counted by different sized groups (conservation of number)
- Identifies and extends the number pattern that emerge when counting by equal groups
What are the different ways you could count your collection?
What comes in equal groups?

2
- eyes
- ears
- hands
- feet
- shoes

4
- Dog legs
Multiplication:

What items come in "groups of"? Can you think of items for numbers 1 – 12?
Multiplication:
How can hundreds charts help you think about your question?

9 x 6 = 54
9 x 7 = 63
I can skip count:
9 jumps of 6 is 54
9 x 6 = 54
Multiplication:
How do T charts help us to count groups of items?

$4 \times 9 = \quad$ 

$\begin{array}{c}
8 \\
18 \\
27 \\
36
\end{array}$
Multiplication:
How are repeated addition and multiplication connected?
How do we help our students develop understanding of multiplying equal groups?

- Counts groups as single entities (unitizes)
- Distinguishes between number of groups and number of objects in a group
- Show with models “a number of groups of a certain size” when the language of “groups of” is presented with various terms (e.g., “piles of,” “stacks of,” “rows of,” “cups of,”)
- Interprets word problems using models and drawings showing the number of groups and the number in each group
- Records number of groups in each step of a skip counting pattern, relating it to multiplication (Repeated addition and skip counting)
How many? How many in each? How many altogether

4 groups of 2 = 8
4 x 2 = 8
### Multiplication:
What multiplication game(s) can you create?

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<th>Julie</th>
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<td>16</td>
<td>5 x 6</td>
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<td>30</td>
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<td>25</td>
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</tbody>
</table>
Circle and Stars

A Marilyn Burns classic! Play with a partner. Each game has eight rounds.

2 x 3 = 6

Look at a page from the story. What question could you ask the multiplication could help you solve? Try it out!
What question might your students ask?
Multiplication:
Create a scene. What multiplication stories can you tell?

5 x 2 = 10 frogs
1 x 3 = 3 elephants
13 animals
Multiplication:

I see ____ groups of ____.

What could I be looking at?

I see 4 groups of 12 roses.
I could be looking at flowers in a store.

I see 3 groups of 2 strawberries.
I could be looking at 6 berries on my plate.
Dim Sum for Everyone!

Your family decides to order Dim Sum for dinner. The dishes of dim sum are served on plates with 3 treats each. How many treats would come to your table?

15 treats would come to our table.

5 groups of 3 = 15

3 + 3 + 3 + 3 + 3 + 3
What if your family received five different servings of Dim Sum?
Amanda Bean’s Amazing Dream
Which Has More?

For each question, explain your thinking using numbers, pictures, and/or words.

Which has more cookies,
- a tray with ___ rows and ___ cookies in each row, or
- a tray with ___ rows and ___ cookies in each row?

Which has more wheels, ___ tricycles or ____ bicycles?

Thanks to Marc Garneau for sharing these!
\[(2 \times 10) + (10 \times 2) = 20 + 20 = 40 = 20\]
How do we assist students in multiplying using rectangular arrays?

- Builds rectangular arrays using “rows of”
- Describes arrays in terms of equal groups (usually by rows)
- Partitions arrays into smaller arrays
- Describes arrays in terms of equal groups when the array is only partially visible
Can you represent the arrangement of ___ flies? How might you describe it?
Multiplication:

Using square tiles represent a multiplication question that has the same factors (e.g., $7 \times 7$) in an array.

What do you notice? What do you wonder?
How many different ways can you arrange the chocolates?
MEMO: 6 squares

Dear Hershey’s President,

In trying 4 ways but 2 of the ways are switched around which would be the same thing. I would prefer the 3x2 Hershey’s bar because it’s easier to eat.

Sincerely, Bernice & Amisha
Commutative Property

The order of the factors does not matter - the product is still the same!

\[ 6 \times 4 = 4 \times 6 \]
\[ 24 = 24 \]
Diminish consciousness of self
Improvisational potential
Continuation Desire
MEMO: 17 squares

Dear Hershey’s President,

We found 1 way to wrap a 17 square chocolate bar. We prefer the only way witch is 17 by 1.

Sincerely,
Multiplication:
How do squares and rectangles help you to think about your question?

$5 \times 7 = \boxed{35}$
Can you create some of the arrays you might see at night in the city?
**Multiplication:**

Fish like to swim in schools (groups). Pick a number of fish. How many different equal groups can be made from your fish?
How many different ways can you represent your question?
Using a fact they know and compensating.

Representing with arrays

Connection to repeated addition

Applying skip counting

Representing groups of

Connection to division and related facts
Take a close look at their work. Are they representing their question or showing different ways to make 12? What questions might you ask these students?
What happens when you multiply an even # x even # or and odd # x odd # or an even # x odd #? 

Example:

\[ 4 \times 4 = 16 \]

\[ 4 + 4 + 4 + 4 \]
Can you arrange ___ penguins into equal groups? Can you describe the ways using multiplication? How is this related to division?

What materials might you provide?
What other equal groups can you put the penguins in?

6 out of ten.
What other equal groups can you put the penguins in?
“Mathematizing a read-aloud provides students with opportunities to learn mathematical concepts in meaningful contexts. Using literature to connect concepts with students’ experiences helps foster understanding and motivates students to learn.”

~ Hintz and Smith (2013) Mathematizing Read-Alouds
What are all the possible ways that 99 ants can line up equally?

1 x 99
9 x 11
3 x 33
33 x 3
11 x 9
99 x 1

99 \div 3 = 33
33 + 33 + 33 = 99
Repeated Addition
3 \times 33 = 33 + 33 + 33
33 \times 3

Identity Element:
1 \times 99 = 99
Commutative Property:
99 \times 1 = 99

33, 33, 33
What do you notice about the information?

What do you notice about the even numbers? The odd numbers?

Why do numbers have different factors?

What about the numbers that only have 2 factors. Why might that be?

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<td>1,43</td>
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<tr>
<td>44</td>
<td>1,2,4,11,22,44</td>
</tr>
</tbody>
</table>
How do we assist students in using multiplicative thinking to solve single and multi-digit multiplication questions.

- Using known facts and compensating
- Doubling and Halving
- Making landmark or friendly numbers
- Using the commutative property
- Using the distributive property
- Using the associative property
How does halving and doubling help you solve a question you don’t know?

What do you notice is happening?

Let’s record what each brother ordered?

How could we describe this using multiplication?

How many dishes did Minnie use for _____’s meal?

How many dishes did Minnie use to feed all the brothers?
Multiplication:
How can you use Cuisenaire rods to represent your question?

- 3 × 6 = 3 red rods
- 6 × 17 = 17 yellow rods
- 6 × 18 = 18 red rods

On the clipboard:

1. \[ 6 \times 18 = \]
2. \[ (6 \times 10) + (6 \times 8) = 108 \]
3. 2 nd step: OK
4. \[ 6 \times 18 \]
5. \[ (6 \times 9) + (6 \times 9) = 108 \]
\[ 6 \times 18 = \]

1. \[ 6 \times 18 = \]
   \[ 6 \times (10 \times 8) \]
   \[ (6 \times 10) + (6 \times 8) = 108 \]

2. \[ 6 \times 18 = \]
   \[ 6 \times (9 \times 9) \]
   \[ (6 \times 9) + (6 \times 9) = 108 \]
DISTRIBUTIVE PROPERTY

You can break a factor up and distribute the multiplication across both factors!

\[ 2 \times 33 = 2 \times (30 + 3) \]
\[ (2 \times 30) + (2 \times 3) \]
\[ 60 + 6 = 66 \]
Multiplication:

How can you represent your question using ten frames?

6 x 7 = 42
(6 x 5) + (6 x 2) = 42
30

7 + 7 + 7 + 7

14 + 14 + 14
24 + 16 + 12 = 42
30 + 12 = 42

2 x 18 =
Multiplication:
How can you represent your question using base 10 blocks?

3 x 12 =

4 x 12 =

Break Factor into two

3 x (10 + 2) = (3 x 10) + (3 x 2) = 36

---

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---
How does halving and doubling help you solve a question you don’t know?

4 \times 8 = \text{?}
How does halving and doubling help you solve a question you don’t know?

$4 \times 8 = 2 \times (2 \times 8)$
How does halving and doubling help you solve a question you don’t know?

$4 \times 8 = 2 \times (4 \times 4)$
ASSOCIATIVE PROPERTY

How you group the factors does not matter - the product is still the same!

\[(6 \times 4) \times 2 = 6 \times (4 \times 2)\]
\[24 \times 2 = 6 \times 8\]
\[48 = 48\]
How can you use facts you know to help you solve a question you don’t know?

https://www.mathlearningcenter.org/resources/apps

Number Rack
Number Rack facilitates the natural development of children’s number sense. Rows of movable, colored beads encourage learners to think in groups of fives and tens, helping them to explore and discover a variety of addition and subtraction strategies. Free activities and free book available.
Resources
Math Apps

5  9

5  4

25  20

(5x5)  +(5x4)

9
$6 \times 5 = 30$

Plus

$6 \times 2 = 12$

$30 + 12 = 42$
You use facts you know to help you solve questions you don’t know?

\[(\frac{3 \times 5}{30}) + (\frac{3 \times 3}{3}) = \]

\[8 \times 3 = \]

\[(4 \times 3) + (4 \times 3) = 8 \times 3\]
Children have real understanding only of that which they invent themselves, and each time that we try to teach them too quickly we keep them from reinventing it themselves.

- Piaget
How can you use facts you know to help you solve a question you don’t know?

https://www.mathlearningcenter.org/resources/apps
12 \times 8 = 12 \times 8

(10 \times 8) + (2 \times 8) = 12 \times 8

(2 \times 8) + (10 \times 8) = 12 \times 8
Same site - this is called Number Pieces
Three Act Tasks

1) The Question, 2) Gathering Information, and 3) The Reveal. The entire activity typically takes a full math period or the acts can be split up and worked on across multiple days. The goal of the activity is to engage children in asking mathematical questions, identifying information that will allow them to answer the question, developing a mathematical model of the situation, and revising their models to more closely reflect the real world.
Act One
Act Two

There are 58 packages of skittles in the jar.
Act Three
“Play is often talked about as if it were a relief from serious learning. But for children play is serious learning. Play is really the work of childhood.”

Fred Rogers
What is our role in playful inquiry?

- talk less and listen more
- be open to the children’s questions
- ask open questions - design inviting, playful learning opportunities
- notice and name the curricular competencies
- ask questions to nudge learning
- use mathematical vocabulary
- build in time to reflect and connect
- know and honour student’s interests
- establish a culture that supports wondering and playfulness
We circulate and observe. Based on what we see, we ask questions to clarify our understanding and nudge learning forward.

We document the learning we see using anecdotal notes, photos, videos, checklists, collection of student work samples.
Performance Based Assessment

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<th>Grade 3 / Div. 12</th>
<th>Increasing Patterns</th>
<th>Decreasing Patterns</th>
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Oct. 11/17

Patterns

2017-18
Journal Prompts

- Multiplication can be represented using
- I created...
- I’m proud of...
- I know...
- I’m thinking now...
- This reminds me of...
- Today I learned...
- A connection I have...
- I noticed...
Multiplication: How do we revisit this topic throughout the year?
Number Talks Using Quick Images

Learning Intentions:

- develop multiple strategies for Decomposing (Mental Math)
- developing flexibility through use of multiple strategies
- Computational Fluency
- Place Value
How many?
How did you see them?
How could we describe this page using multiplication?

How many legs are there altogether?

How many horns?
How many?
How did you see them?
How many?
How did you see them?
\[(6 \times 5) + (6 \times 1)\]
How many?
How did you see them?
How many?
How did you see them?
(8 \times 10) - 8 = 72
How many?
How did you see them?
How does thinking about the first image we saw help us with this new image?
Learning Intentions:

• develop multiple strategies for Decomposing (Mental Math)
• developing flexibility through use of multiple strategies
• Computational Fluency
• Place Value

10 - 15 minutes focussed on one question or a “string” of questions

\[
\begin{align*}
18 + 7 &= \quad 6 \times 600 \\
\phantom{18 + 7} &= 10 \times 600 \\
\phantom{18 + 7} &= 16 \times 600 \\
\phantom{18 + 7} &= 16 \times 599
\end{align*}
\]
Two-digit x Two-digit example

- https://www.teachingchannel.org/videos/4th-5th-grade-number-talks
SAME AND DIFFERENT

What’s the learning?:

• identifying relationships between objects, shapes, and numbers
• using reasoning to construct arguments when comparing objects, shapes, and numbers
• develop their ability to communicate mathematical ideas
What is the same?
What is different?
SAME OR DIFFERENT?
supporting mathematical argument in the elementary grades

https://samedifferentimages.wordpress.com/
Website curated by Brian Bushart et al.
#samedifferent
True or False

= 5 \times 2
True or False

$3 + 3 + 3 = 4 \times 3$
True or False

\[= 4 \times 5\]
TRUE OR FALSE

$2 \times 3 \times 4 = 3 \times 4 \times 2$
TRUE OR FALSE

$4 \times 4 = 2 \times 8$
TRUE OR FALSE

2 \times 3 \times 4 = 3 \times 4 \times 2

Does the order of factors matter?

24 = 24

(2 \times 3) \times 4 = (4 \times 2) \times 3

Factors

Inline Skating: 10:30

Commulative Property

3 \times 4

4 \times 3

Associative Property
### Multiplication Games

**Cover Up! A Doubles Game**
- **How to Play**
  - Roll a 6-sided die. Multiply your number by 2.
  - Find it on the grid and cover it in your color.
  - Partner Z gets a turn.
  - The first one to have 4 in a line wins!
  - Roll a 0 and lose a turn!

<table>
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<th>12</th>
<th>6</th>
<th>10</th>
<th>12</th>
<th>4</th>
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</tbody>
</table>

**Double or Double-Double**
- **How to Play**
  - Pick a factor from the **Factor Box**.
  - Double it (multiply by 2) or double-double it (multiply by 4).
  - Find the product below and cover it in your colour.
  - Four in a row wins!

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<th>1</th>
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<th>3</th>
<th>4</th>
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<td>10</td>
<td>12</td>
<td>14</td>
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</tbody>
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<table>
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<th>8</th>
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<th>20</th>
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</tbody>
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Key Resources:
Teachers who love teaching, teach children to love learning.