Engaging in Mathematics Through Playful Inquiry

Afternoon - August 30th, 2018

Cambridge/Bayride Elementary Schools

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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.

Think of a time this summer when you engaged in play. What words and/or feelings would you use to describe you experience?

play

/plā/

verb

1. engage in activity for enjoyment and recreation rather than a serious or practical purpose.
   "the children were playing outside"
   synonyms: amuse oneself, entertain oneself, enjoy oneself, have fun; More

2. take part in (a sport).
   "I play softball and tennis"
   synonyms: take part in, participate in, be involved in, compete in, do
   "I used to play hockey"

noun

1. activity engaged in for enjoyment and recreation, especially by children.
   "a child **at play** may use a stick as an airplane"
   synonyms: amusement, entertainment, relaxation, recreation, diversion, distraction, leisure; More

2. the conducting of an athletic match or contest.
   "rain interrupted the second day's play"

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JOY

CREATIVITY

COLLABORATION

EXCITEMENT

WONDER

ENGAGEMENT

THINKING

STRATEGY

ShadowCon - Kassia Wedekind on Math Play

What is PLAY?

Diminished consciousness of self

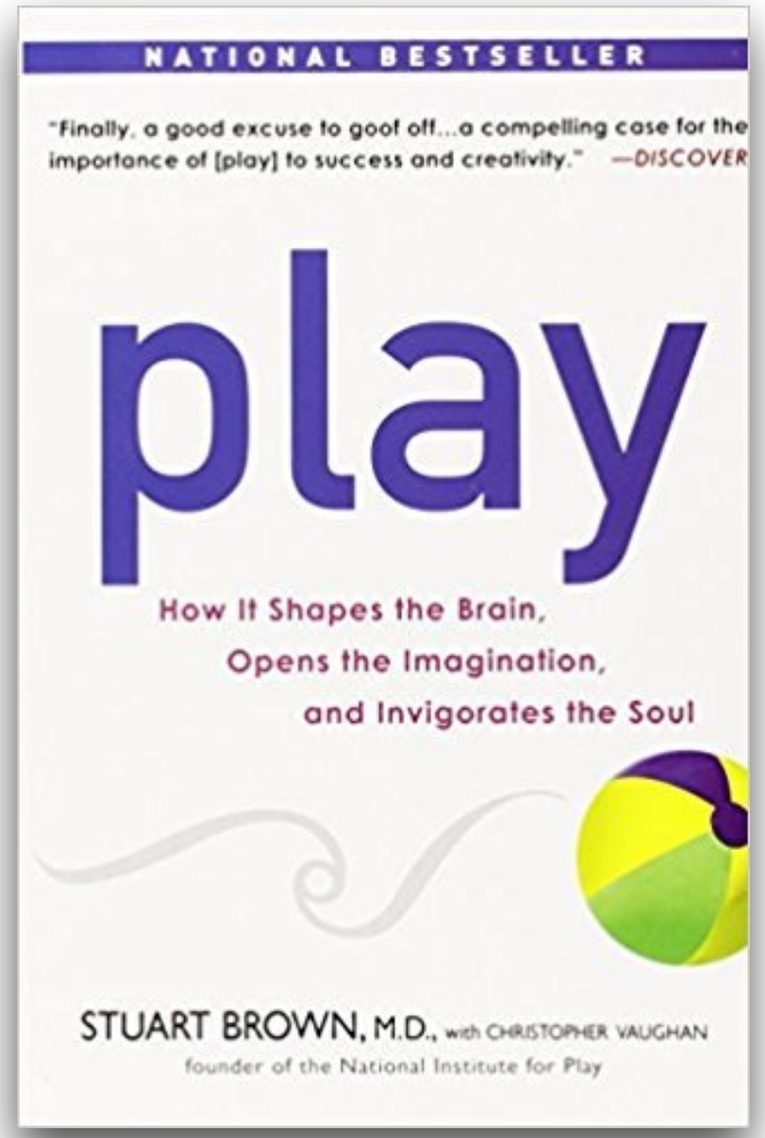
- no good or bad
- willingness to take risks

Improvisational Potential

- its openness
- co-constructing understanding

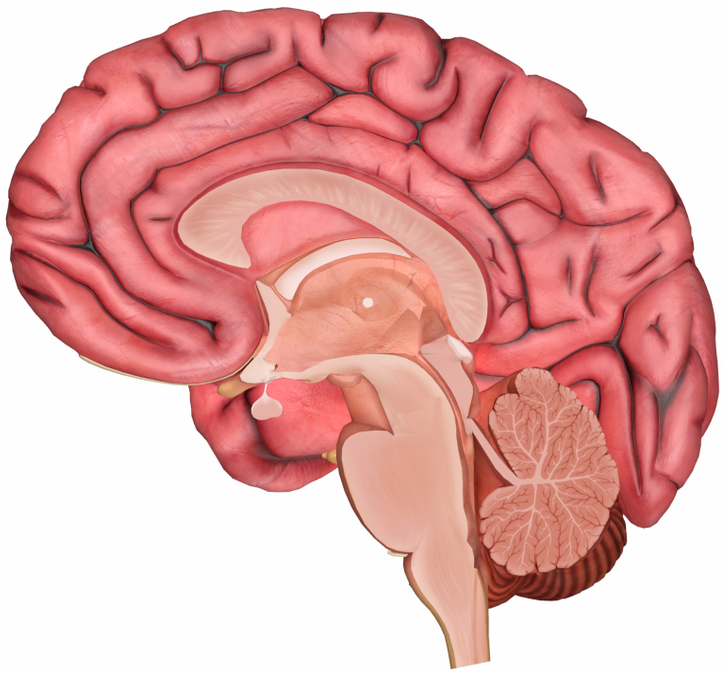
Continuation Desire

- it hooks! Focused attention
- self motivated



"Neuroscience has shown use that the brain is highly complex...Play literally sculpts the brain, giving us the resources we need to meet the challenges we face in our daily lives."

– Susan Harris McKay (2012) What is Play?



Burgart (2011) Five criteria for recognizing play...

- is spontaneous or pleasurable
- initiated in the absence of stress
- light hearted
- repeated
- freely chosen

In addition, PLAY can provide:

- opportunities for social engagement
- language skills
- creative thinking / imagination
- critical thinking
- use of materials that are appealing
- physical skills and coordination
- confidence building
- motivation
- engagement
- development of cognitive skills
- residence and coping skills
- a sense of wonder

It's true for animals as well!

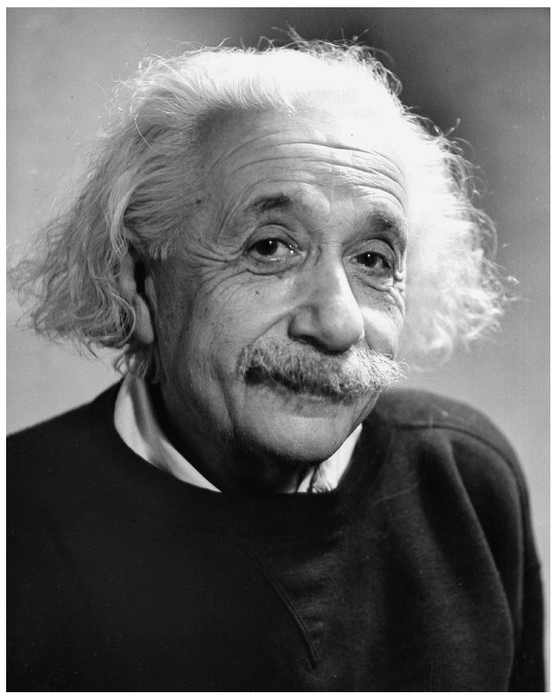
“Play is the engine of learning”

- Dan Finkel (2017) Virtual Math Summit

“... then what is teaching?”

We are architects of learning!

"I never teach my pupils; I only attempt to provide the conditions in which they can learn."

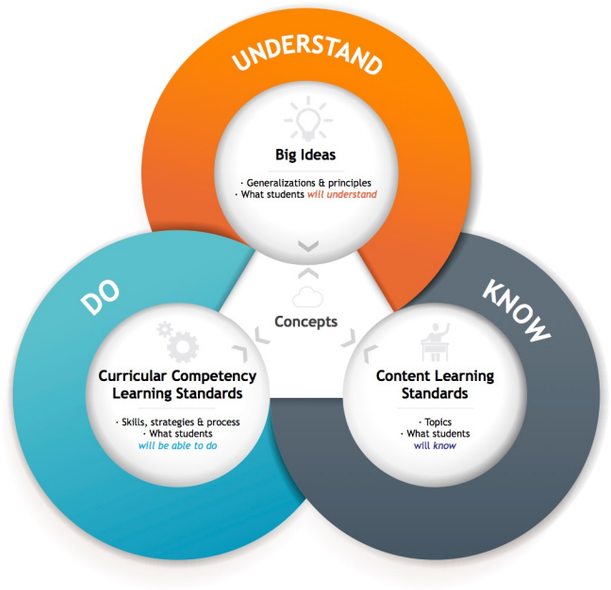


- Albert Einstein

How do I begin to design these learning experiences?

- Think about your students' interests and curiosities

- Consider the curriculum - What big ideas do you want your students to understand? What competencies and content will support this?



Mathematics 6

Core Competencies

Big Ideas

Mixed numbers and decimal numbers represent quantities that can be decomposed into parts and wholes.

Computational fluency and flexibility with numbers extend to operations with whole numbers and decimals.

Linear relations can be identified and represented using expressions with variables and line graphs and can be used to form generalizations.

Properties of objects and shapes can be described, measured, and compared using volume, area, perimeter, and angles.

Data from the results of an experiment can be used to predict the theoretical probability of an event and to compare and interpret.

Learning Standards

Show All Elaborations

Curricular Competencies

Students are expected to be able to do the following:

Reasoning and analyzing

Content

Students are expected to know the following:

- small to large numbers (thousandths to billions)

Learning Standards

Show All Elaborations

Curricular Competencies

Students are expected to be

PLAY and INQUIRY

Reasoning and analyzing

- Use logic and patterns to solve puzzles and play games
- Use reasoning and logic to explore, analyze, and apply mathematical ide
- Estimate reasonably
- Demonstrate and apply mental math strategies
- Use tools or technology to explore and create patterns and relationships test conjectures
- Model mathematics in contextualized experiences

Understanding and solving

- Apply multiple strategies to solve problems in both abstract and contex situations
- Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving
- Visualize to explore mathematical concepts
- Engage in problem-solving experiences that are connected to place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures

Communicating and representing

- Use mathematical vocabulary and language to contribute to mathematical discussions
- Explain and justify mathematical ideas and decisions

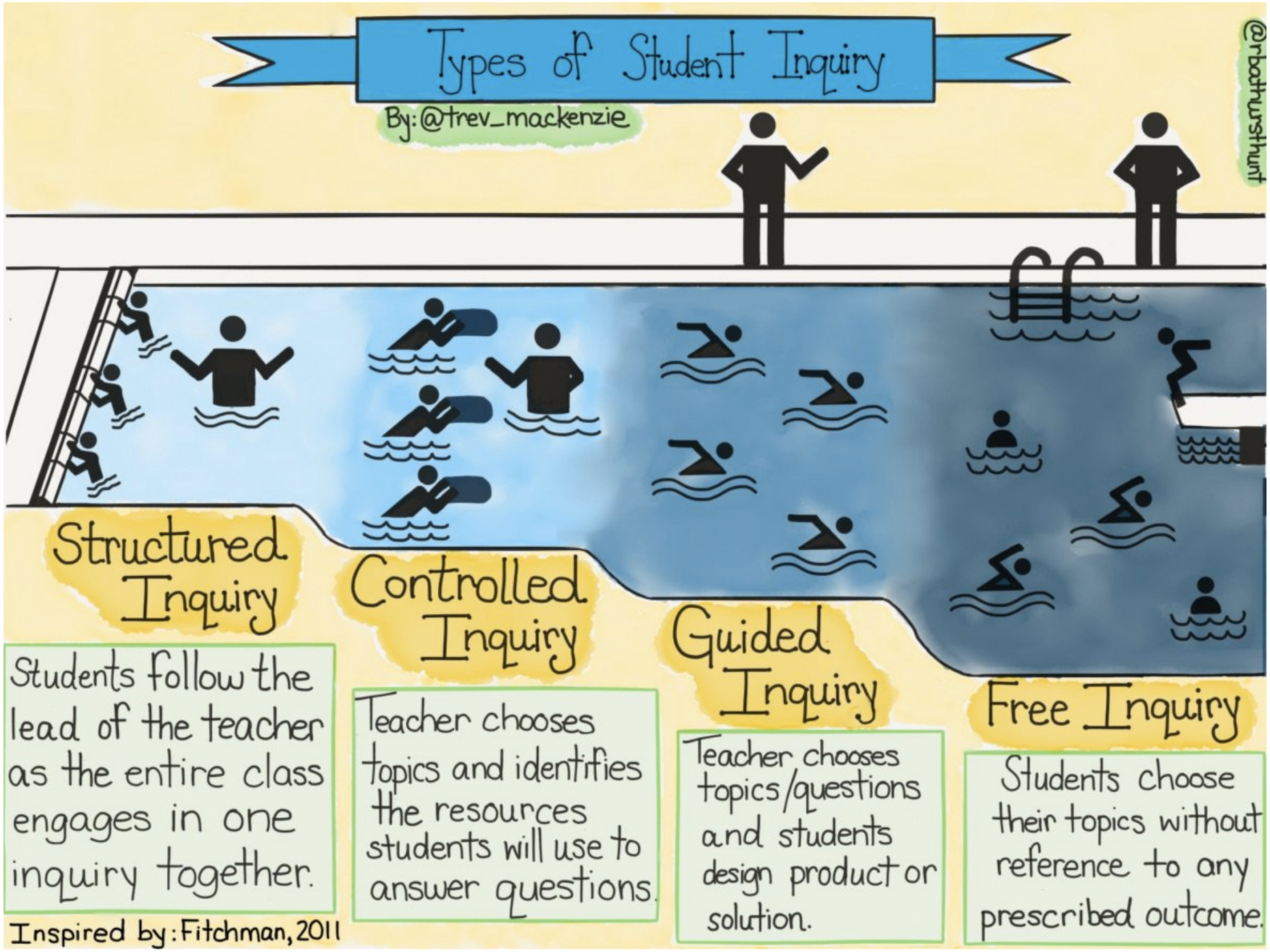
following:

- ndths to billions)
- multiplication and division facts to 100 (developing computational fluency)
- order of operations with whole numbers
- factors and multiples — greatest common factor and least common multiple
- improper fractions and mixed numbers
- introduction to ratios
- whole-number percents and percentage discounts
- multiplication and division of decimals
- increasing and decreasing patterns, using expressions, tables, and graphs as functional relationships
- one-step equations with whole-number coefficients and solutions
- perimeter of complex shapes
- area of triangles, parallelograms, and trapezoids
- angle measurement and classification
- volume and capacity
- triangles
- combinations of transformations

Play + Inquiry =

...Invites a playful stance toward learning. Teachers can offer provocations, such as open-ended questions, engaging and inviting materials for children to explore.

Types of Inquiry



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 a guiding question.
- The students will 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 students and/or the teachers 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

How could this look in your class?

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 materials at each table
- could have 2, 3, or 4 questions

Individual or Partner Open Inquiry

- Lots of different questions
- Many different materials dependent on what students choose

Why use this approach? What affordances come from inquiry?

Traditional learning	Inquiry learning
Have to learn	**Want to learn**
What to know	**How to know**
Tell and memorize	**Ask and inquire**
Only one right answer	**Many conclusions**
Teacher-directed	**Learner-centred**
One-size-fits-all	**Personalized**
Passive learning	**Active learning**
Assess for marks	**Assess for learning**

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

How might you incorporate?

- EXCITING literature and materials
- INVITATIONS to the students - artifacts or questions
- Opportunities for CONNECTIONS to themselves, community, content
- MULTI-MODAL EXPERIENCES - hands on, kinaesthetic, visual, auditory
- Opportunities for COLLABORATION
- CHOICE - increases motivation!
- Opportunities for learning to be RECURSIVE

Types of Provocations

Direct Prompt

Implied Prompt
through Modelling

and Open Exploration!

Please take some time to PLAY! What different provocations are you noticing? What are you wondering?

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/model mathematical vocabulary
- build in time to reflect and connect
- know and honour student's interests
- establish a culture that supports wondering and playfulness

Tips for Asking Effective Questions

- Anticipate student thinking
- Know your LEARNING STANDARDS
- Think about about some of the questions you could ask
- Incorporate verbs that elicit higher levels of thinking
- Pose questions that open up the conversation to include others
- Keep questions neutral
- Provide wait time

Getting Started *Questions and Prompts to Get Students Thinking*

Stimulate thinking by asking open-ended questions ...

- How else could you have ...?
- How are these _____ the same?
- How are these different?
- About how long ...? (many, tall, wide, heavy, big, more, less, etc.)
- What would you do if ...?
- What would happen if ...?
- What else could you have done?
- If I do this, what will happen?
- Is there any other way you could ...?
- Why did you ...?
- How did you ...?

To Help Students Share Their Representations

(and show / describe / demonstrate / represent)

Questions to pose:

- How have you shown your thinking (e.g., picture, model, number, sentence)?
- Which way (e.g., picture, model, number, sentence) best shows what you know?
- How have you used math words to describe your experience?
- How did you show it?
- How would you explain _____ to a student in Grade ___? (a grade lower than the one the student is in)

Prompts to use:

- I decided to use a ...
- A graph (table, T-chart, picture) shows this the best because ...
- I could make this clearer by using a ...
- The math words that help someone understand what I did are ...

To Help Students Reflect on Their Work

(and analyze / compare / contrast / test / survey / classify / sort / show / use / apply / model)

Questions to pose:

- What mathematics were you investigating?
- What questions arose as you worked?
- What were you thinking when you made decisions or selected strategies to solve the problem?
- What changes did you have to make to solve the problem?
- What was the most challenging part of the task? And why?
- How do you know?
- How does knowing _____ help you to answer the questions _____?

Prompts to use:

- A question I had was ...
- I was feeling really ...
- I decided to _____, I was thinking ...
- I found _____ challenging because ...
- The most important thing I learned in math today is ...

To Help Students Make Connections

(and connect / relate / refer / imagine / describe / compare)

Questions to pose:

- What does this make you think of?
- What other math can you connect with this?
- When do you use this math at home? At school? In other places?
- Where do you see _____ at school? At home? Outside?
- How is this like something you have done before?

Prompts to use:

- This new math idea is like...
- I thought of ...
- I did something like this before when ...
- We do this at home when we ...
- I remember when we ...

To Help Students Share Their Feelings, Attitudes or Beliefs about Mathematics

(and share / reflect / describe / compare / tell)

Questions to pose:

- What else would you like to find out about _____ ?
- How do you feel about mathematics?
- How do you feel about _____ ?
- What does the math remind you of?
- How can you describe math?

Prompts to use:

- The thing I like best about mathematics is ...
- The hardest part of this unit on _____ is ...
- I need help with _____ because ...
- Write to tell a friend how you feel about what we are doing in mathematics.
- Mathematics is like _____ because ...
- Today, I felt ...

To Help Students Retell

(and tell / list / recite / name / find / describe / explain / illustrate / summarize)

Questions to pose:

- How did you solve the problem?
- What did you do?
- What strategy did you use?
- What math words did you use or learn?
- What were the steps involved?
- What did you learn today?
- What do(es) _____ mean to you?

Prompts to use:

- I solved the problem by ...
- The math words I used were ...
- The steps I followed were ...
- My strategy was successful because ...
- Explain to a young child or someone that wasn't involved ...
- Draw a picture to show how you solved the problem.

To Help Students Predict, Invent or Problem Solve

(and create / plan / design / predict / imagine / devise / decide / defend / solve / debate)

Questions to pose:

- What would happen if ...?
- What decisions can you make from the pattern that you discovered?
- How else might you have solved the problem?
- Will it be the same if we use different numbers?
- What things in the classroom have these same shapes?
- How is this pattern like addition?
- What would you measure it with? Why?
- How are adding and multiplying the same?

Prompts to use:

- Prove that there is only one possible answer to this problem.
- Convince me!
- Tell me what is the same? What is different?
- How do you know?

Stimulate thinking by asking open-ended questions ...

- How do you know?
- What does (this) _____ represent?
- How did you know where ...?
- How did you know which ...?
- How did you know when ...?
- Could you use some other materials to ...?
- How could you record your work?
- How could you record your discovery?
- How could you share your discovery?
- How did you estimate what the answer could be?
- How did you prove your estimate?

Formative Assessment

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. It is important to make the students' thinking visible!

Time to Try…
turn to page 3

Either by yourself or with a colleague(s) try planning a playful inquiry learning experience!

Playful Planning…

Think about a **CONCEPT** you want your students to explore this year…

What **PROVOCATIONS** could you provide?

What **PLAYFUL MATERIALS** could you provide for this exploration?

What **COMPETENCIES** might be fostered?

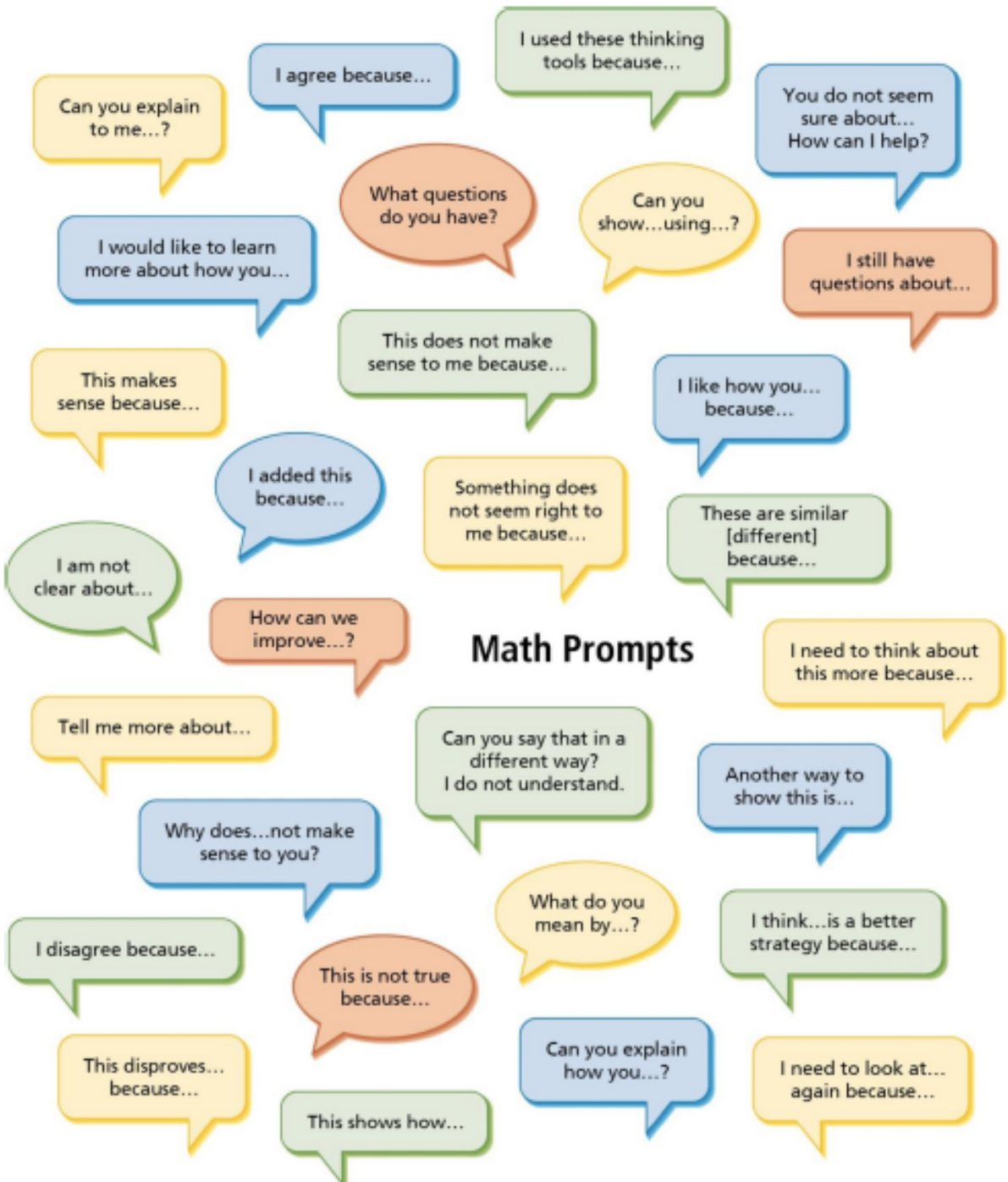
What **GUIDING QUESTIONS** will you ask to make **THINKING** visible and nudge the learning?

GAMES

1 - 2 NIM

- Find a partner
- Count out 20 counters
- Take turns with a partner - On your turn you can take one or two counters away
- Whoever takes the last counter is the winner.

Is there a winning strategy?
Use the Talking Points to help you share your Mathematical Thinking!



Debriefing 1 - 2 NIM

What Core and/or Curricular Competencies were fostered?

Creativity is
EXPERIMENTING,
GROWING, TAKING
RISKS, BREAKING
RULES, MAKING
MISTAKES, &
HAVING FUN.

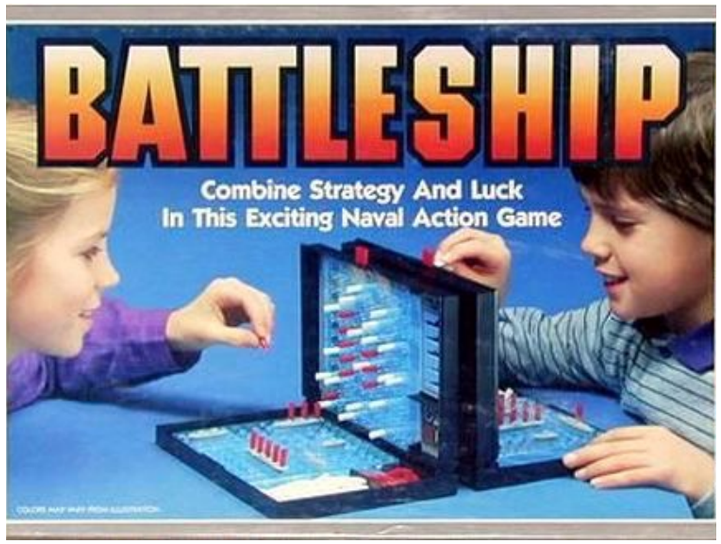
-Mary Lou Cook

Some potential knowledge that can be fostered through games...

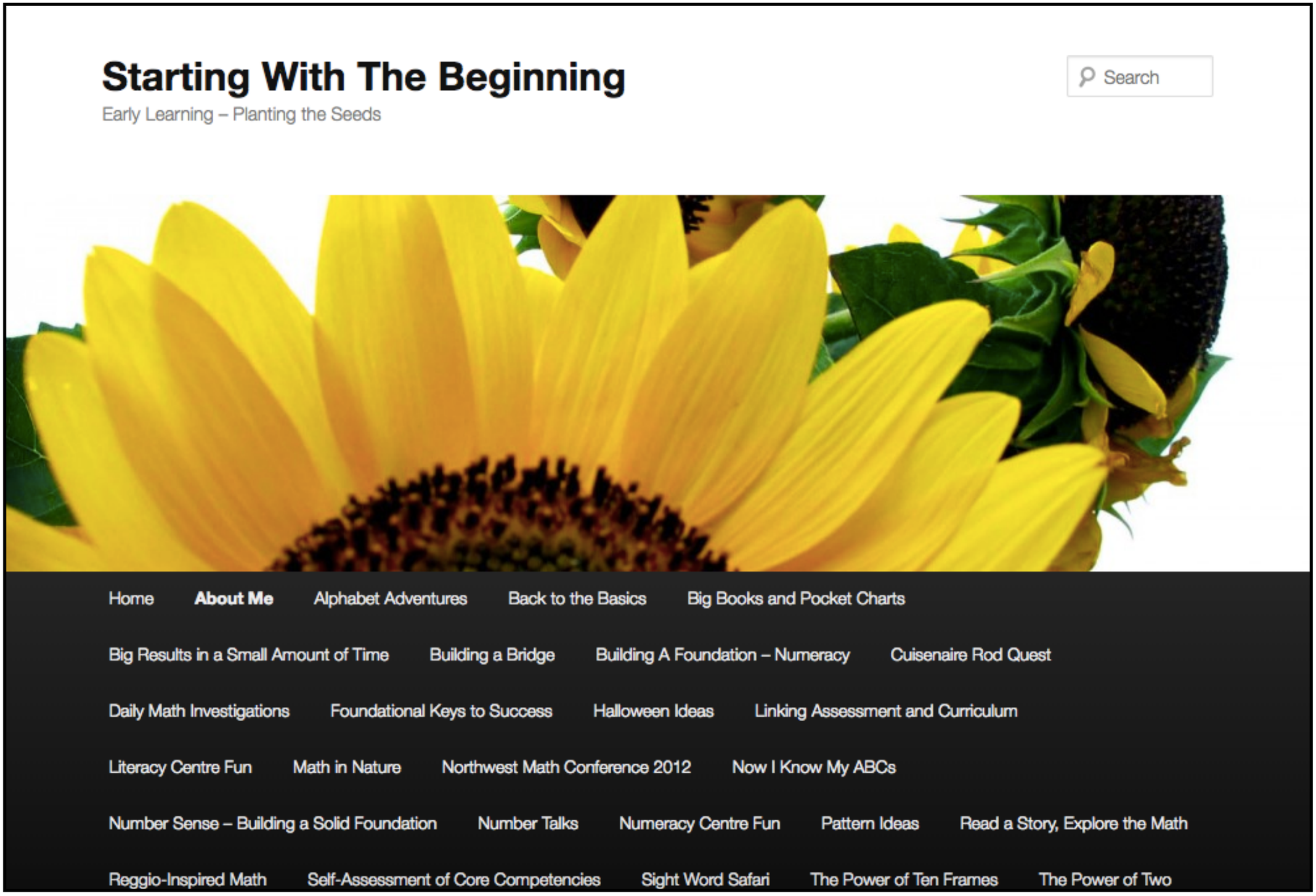
- Counting - movement along a series of spaces
- Estimating - seeing magnitudes in a linear way - equal sized numbered squares
- Recognizing Patterns
- Number Relationships - rolling dice leads to thinking about more and less
- Mental Math - adding and subtracting - how many more spaces do I need to go? Division - movement among pawns in the game of Trouble.
- Probability

GAME TIME!

How can you bring games to life in your classroom?



Primary Games can be found on Sandra Ball's Website



Numeracy Centres

What's Included?

Penguin Package

What's Inside?

1. Domino Penguin Match - Matching Activity – 1 set

- students match quantities on a penguin with the numerals on a matching penguin

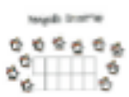
2. Feed Me - Individual - BLMs

- reinforce partitioning of numbers into 2 parts.
- students use 2 sided counters and sort them into 2 parts

3. Penguin Cover Up Five Frame - Individual

- roll the 1 – 6 sided die
- cover the rolled quantity on to the five frame
- students could record on a blank five frame the quantity (using bingo dabbers or felts)
- ask "How many more/less to get to 5?"

4. Penguin Cover Up 0 -10 - Individual



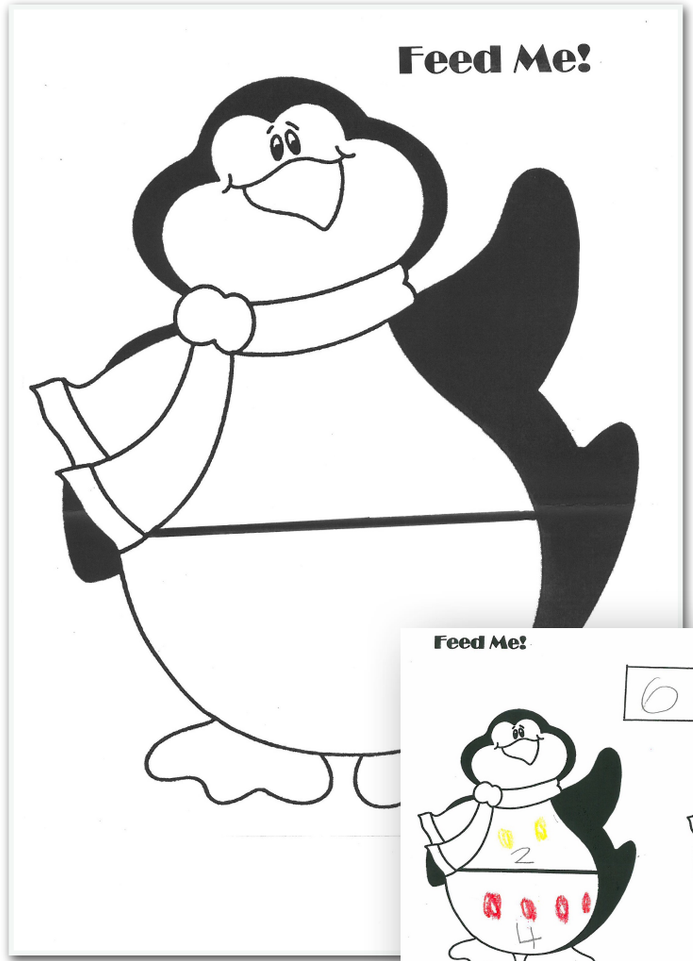
- player #1 needs to roll die (0 – 9 sided)
- build quantity on a ten frame and cover up the numeral
- students could record on a blank ten frame the quantity (using bingo dabbers or felts)
- ask "How many more/less to get to 10?"

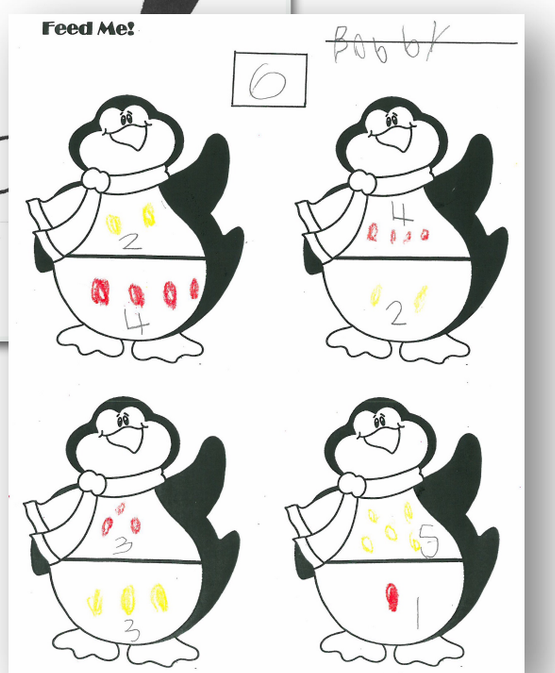
5. Penguin Cover Up 1-10 - Partner Game - BLM

- player #1 needs to roll a(1 – 10 sided) die
- build quantity on the ten frames and cover up the numeral
- players take turns rolling the die, building the quantity and covering the numeral
- first one to cover all the numerals wins

6. Penguin Cover Up 2 -12 - Partner Game - BLM

- player #1 needs to roll 2 (1 – 6 sided) dice and find the sum
- build the sum on the ten frames and cover up the numeral
- players take turns rolling the die, building the quantity and covering the numeral
- first one to cover all the numerals wins





COVER UP!

Doubles!

12	6	10	12	4	8
14	18	8	16	8	6
6	10	14	12	10	14
12	4	8	18	16	10
14	16	18	14	4	14
2	8	4	10	16	18

Roll the die. Double the number.
Find it on the grid and cover it in your counter.
Give you partner a turn.
First one to have 4 in a row wins!

Chips Ahoy!

3	7	5
19	15	13
11	17	9

- Place 15 chips on the game board. Chips can be placed anywhere, and doubles on a space are OK.
- Roll a 10 sided die (0-9).
- Double and add 1 to the number rolled, then remove a chip from the space that shows the sum.

  For example: Player A rolls a 2, say the near double fact (2 + 2 +1 is 5 or 2 + 3 = 5) and takes a chip off the 5 space.
- Roll a zero and take a chip from any space!
- Players take turns until one player has collected 8 chips. This person is the winner!

Available on Sandra Ball's website

"How can thinking about 'doubles' help you solve 6 + 7 = "

Multiplication Games

Cover Up! A Doubles Game

You need
~ 10 sided dice
~ Counters (2 different colors)

How to Play
Roll a 10-sided die. Multiply your number by 2.
Find it on the grid and cover it in your color.
Partner 2 gets a turn.
The first one to have 4 in a line wins!
Roll a 0 and lose a turn!

12	6	10	12	4	8
14	18	6	16	2	6
6	10	2	12	10	14
12	4	8	18	16	10
14	16	2	14	4	12
10	8	4	2	16	18

Double or Double-Double

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!

Factor Box

1	2	3	4	5	6
7	8	9	10	12	14

24	8	6	20	12	4
16	28	14	32	18	24
10	2	6	36	28	40
12	14	18	4	16	20
10	8	24	32	36	2
40	28	18	16	4	6

Multiplication – What's Inside?

1. Cover Up! – Partner Game

- doubling strategy (x2)
- place 4 markers in a row
- differentiated instruction—strategic game

2. Double or Double-Double – Individual Activity

- based on doubling strategy (x4)
- place 4 markers in a row
- differentiated instruction—strategic game

3. Doubles and Halves – Partner Game

- relating multiplication and division (x/÷2)
- create longest row of markers
- differentiated instruction—strategic game

4. Doubles in a Row – Partner Game

- doubling strategy (x2)
- limited counters, place 3 in a row
- differentiated instruction—strategic game

5. Stack 'em up for 4 – Partner Game

- based on doubling strategy (x4)
- collect most counters
- differentiated instruction—strategic game

6. Stack 'em up for 8 – Partner Game

- based on doubling strategy (x8)
- collect most counters
- differentiated instruction—strategic game

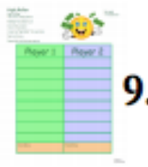
3	6	9
12	15	18
21	24	27

7. Stack 'em up for 3 – Partner Game

- based on doubling +1 more set (x3)
- collect most blocks
- differentiated instruction—strategic game

8. Thinking About Tens – Partner Game

- multiples of 10 (x10)
- place 4 markers in a row
- differentiated instruction—strategic game



9. High Roller – Partner Game

- multiples of 5 (x5)
- highest sum of multiples of 5

10. Multiply by 9 Bingo Card – Partner/small group/whole class

- multiples of 9 (x9)

Instructions

- students record multiples of 9 up to 81 on card
- repetition of multiples is permitted
- using x9 fact cards, call out multiplication facts, others find the product and cover
- line wins the game

11. Square Number Capture – Partner Game

- square numbers
- laminate or slip into page cover
- can relate to area
- variations: capture the greatest area, square spaces need to be connected to one's own continuous space

12. Four in a Line – Partner Game

- doubling/double-double strategy
- larger numbers
- strategic reasoning

13. The Ugly Ones – Partner Game

- multiplication facts not addressed by previous strategies
- encourages students to find efficient strategies based on what they know

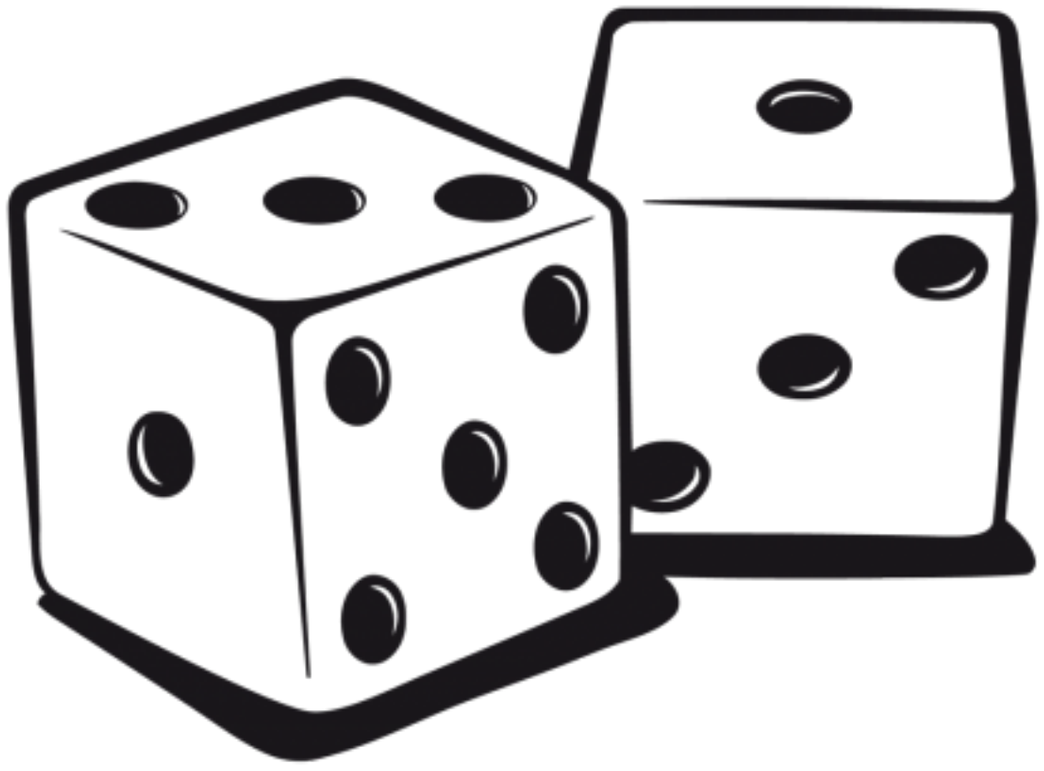
14. Wipe Out – Individual Activity/Partner Game

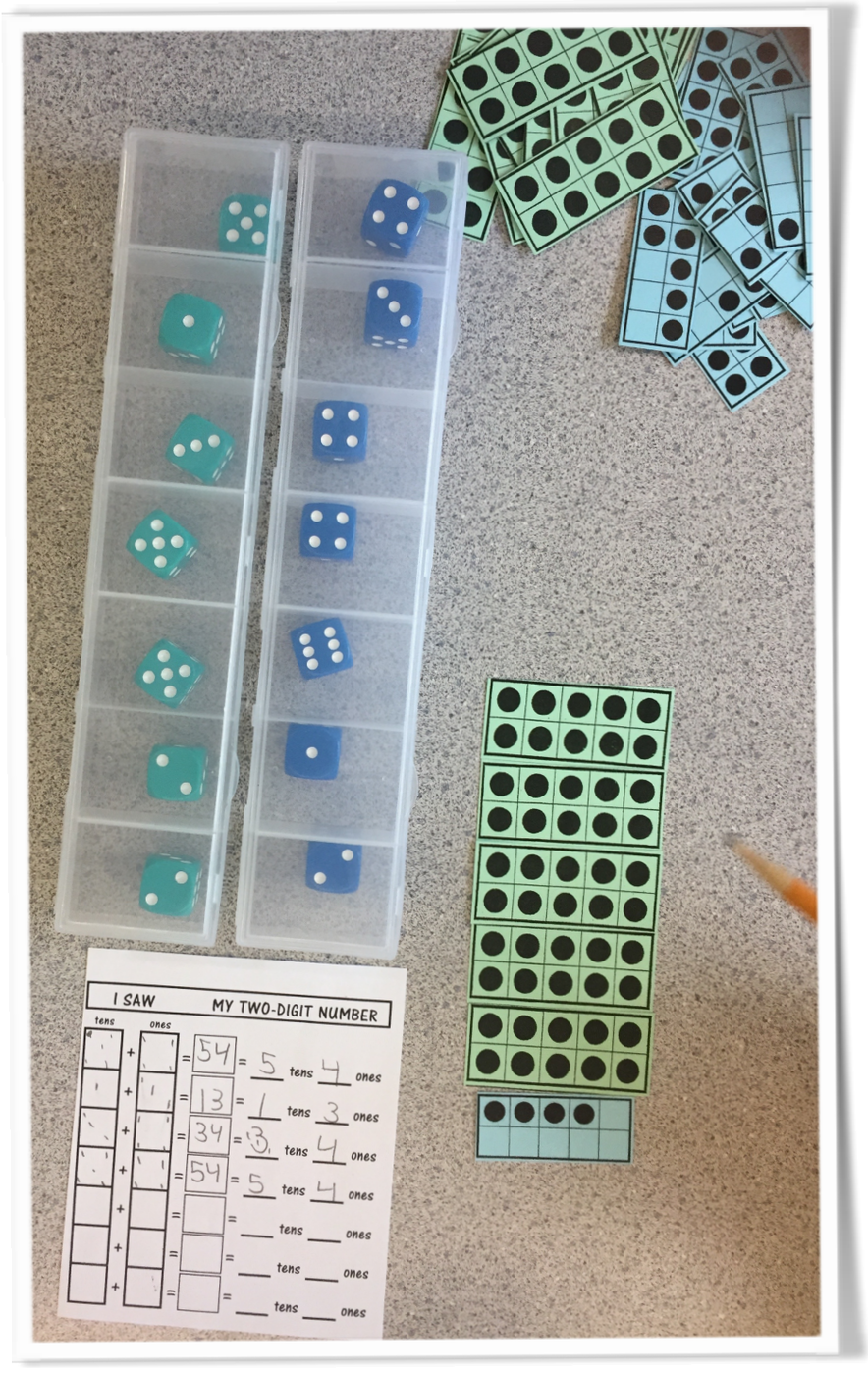
- multi-leveled students can play as partners

Instructions

- before starting, students need to identify a single factor for self
- follow instructions as written on the board

Box Cars and One Eyed Jacks





PLAY GIVES CHILDREN A CHANCE TO PRACTICE WHAT THEY ARE LEARNING.

-MR. ROGERS

Key Resources:

Janice Novakowski's blog & Reggio-inspired work - See handout for links!

What books are to reading, PLAY is to Math!

- Dan Finkel (2017) Virtual Math Summit

Let's Do Whistler

Let's DO MATH

Tracy Zager
Annie Fetter
Graham Fletcher
Michael Fenton
Christina Tondevold
Marian Small & more!

57th Northwest Mathematics Conference

October 18-20, 2018 • www.bcamt.ca/nw2018