Playing games to develop mathematical thinking

WHAT IS MATHEMATICAL THINKING?
HOW CAN WE PLAY GAMES TO HELP DEVELOP IT?
Choose a game that you have at home
What math concepts are you engaged in
What questions might you ask while playing the game? After the game?
Process Expectations

- Which would your students be engaged in during the various games we played?
  - Problem solving
  - Reasoning and proving
  - Reflecting
  - Selecting tools and computational strategies
  - Connecting
  - Representing
  - Communicating

- How can we continue to develop and support our children with regards to the process expectations?
What might be a good question to eliminate many of the people?

Yes – that was a good question! Look how many I was able to put down with that one.
Which piece are you thinking of pulling out? Why that one?
Be sure to look from different points of view and highlight visualizing & structural strength
• How can we get the red car out of the parking lot?
• What did you try moving?
• What else could you try?
Which piece fits where?
Thinking about strategy to win the game
Do you have any cards that you think you will be able to use?

Watch how they adjust as the game goes on

Play together and talk about the why of your decisions
Let’s play Mastermind together
Questions to ask

- What do you like about that game?
- Is there anything you might do differently next time we play that game?
- What math were you playing with in the game?
- How did playing the game help you as a mathematician?
Goals for Math Instruction

A goal of elementary mathematics education: To develop life-long mathematicians who have the knowledge and understanding, thinking and reasoning skills, confidence and perseverance to solve problems in their current and future lives.

• How can we support our children with the different aspects of this goal?
Effective Mathematicians...

- Conjecture, wonder, ask questions, look for patterns and relationships
- See the connections both within the mathematics they are learning and to their lived world
- Think flexibly
- Enjoy being challenged and puzzled and the intrinsic reward of solving a puzzle
- & others
What math do you see?
Research indicates that supporting the development of young children’s mathematical knowledge plays a crucial role in their long-term success in school. In 2007, it was found that mathematics skills among children in Kindergarten were the best predictor of later school achievement, regardless of gender or socio-economic status (Duncan et al., 2007).
Further studies confirm this finding (Claessens, Duncan, & Engel, 2009; Claessens & Engel, 2011), and additional work regarding the specific skills needed to be successful indicates that spatial thinking skills and geometric reasoning play a critical role in the development of problem-solving skills, mathematical learning, and reading comprehension (Clements & Sarama, 2011; Wheatley, Brown, & Solano, 1994; Casey et al., 2008).”

Kindergarten Program Document, 2016
Puzzles

- How did you know that piece went there?
- What part were you looking at?
- Pick the ‘right’ puzzles for their age (matching images, matching spaces, putting small number of pieces together, many pieces) *perseverance
Puzzles
“The reasoning process supports a deeper understanding of mathematics by enabling students to make sense of the mathematics they are learning. The process involves exploring phenomena, developing ideas, making mathematical conjectures, and justifying results. Teachers draw on students’ natural ability to reason to help them learn to reason mathematically. Initially, students may rely on the viewpoints of others to justify a choice or an approach...”
This is your brain on math ...

- Abstract Conceptualization
- Attention
- Number Sense, Estimation, & Mental Arithmetic
- Spatial Reasoning
- Visual Processing
- Motivation
- Arousal
- Memory Formation & Consolidation
- Reasoning and Problem Solving
- Executive Function & Cognitive Control
- Working Memory
Paying Attention to...

Paying Attention to Spatial Reasoning
Support Document for Paying Attention to Mathematics Education

Contents
- Paying Attention to Spatial Reasoning
- What is Spatial Reasoning?
- Why is Spatial Reasoning Important?
- Turning to Research: Reasons to Pay Attention to Spatial Reasoning in Mathematics
- Key Concepts in Spatial Reasoning: Exploring the Role of Spatial Visualization
- Spatial Reasoning across Strands and Grades
- How Can We Promote Spatial Reasoning?
- Ministry Resources and References

Paying Attention to Proportional Reasoning
Support Document for Paying Attention to Mathematical Education

Contents
- Paying Attention to Proportional Reasoning
- What is Proportional Reasoning?
- Why is it Important?
- Exploring Some Key Concepts
- Is it or Isn’t it Proportional?
- How Can We Get Started?
- Being Responsive to Student Thinking
- References

Paying Attention to Algebraic Reasoning
Support Document for Paying Attention to Mathematics Education

Contents
- Paying Attention to Algebraic Reasoning
- Why is Algebraic Reasoning Important?
- What is Algebraic Reasoning?
- Algebraic Reasoning as Generalizing Arithmetic
- Algebraic Reasoning as Functional Thinking
- Actions to Develop Algebraic Reasoning
- Making Connections among Representations
- Algebraic Reasoning through Representation
- Algebraic Reasoning across Strands and Grades
- How Can We Promote Algebraic Reasoning?
- Being Responsive to Student Thinking
- References and Ministry Resources
### 4.9 Reasoning Logically

#### Causality

- identifying actions and outcomes
- identifying evidence for point of view
- exploring causes
- transferring rules from one situation to another
- generalizing knowledge across situations

Include the language of logic in daily interactions.

“You may choose *Caps for Sale* or *Something from Nothing* for group today.”

Words and phrases such as *or, not, if...then, because, some, all, never and probably* reflect thinking and logical connections.

### Sequential Change

- making logical connections
- identifying what precedes change

Avoid non-verbal and verbal responses to children’s thinking that imply “right” or “wrong.” Instead, communicate the message: “That’s an interesting idea.”

As children explore, they may try out one idea. If it fails, they may move quickly to another idea. Learning to consider why the first idea did not work makes children better problem solvers. Children also monitor adult’s reactions to their actions.

When adults communicate “right” or “wrong,” they can cut off children’s thinking.
What reasoning is being developed during various video games?

- Strategy/Problem Solving
- Spatial Reasoning
Card Games

- Cribbage
- Solitaire Games
- ‘Alligator’
- Go Fish
- Uno
- 7 Up

Be Careful – ‘letting’ them win with poor strategies can create misconceptions
How many? How do you know?

Image of 8 + 7

Image of 9 + 7
How close to 100?

- Connecting multiplication to arrays along with strategy (where to draw each one)
Chloe: “I wonder how many wheels are in this picture?”
“…instruction for young children should focus on **number and geometry**. Experiences in the other mathematical areas should also be provided, usually in the context of supporting number or geometry understandings and skills” (Clements and Sarama, p.69)

Have you ever thought of mathematics with this focus? Might this be a more helpful way to think about supporting our children?
Let’s Play a bit more

- Use tangrams to make one of these designs.
Goals for Math Instruction

A goal of elementary mathematics education: To develop life-long mathematicians who have the knowledge and understanding, thinking and reasoning skills, confidence and perseverance to solve problems in their current and future lives.

• How does playing games help our children towards the various aspects of this goal?
“What’s that, Dad?”
As a result of being here tonight I am going to...

- Play games
- Ask questions
- Work to develop reasoning through my interactions with my children