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A CONTINUUM IN MATH INSTRUCTION

Current Math Climate

Discovery Math **vs.** **Direct Instruction**

"Kids used to learn math by doing things like memorizing a multiplication table, and it worked. Instead, our kids are left with experimental discovery math. That hardly teaches math at all. Instead, everyone gets a participation ribbon and our kids are left to fend for themselves."

Doug Ford, 2018

In recent years, more than half of Gr. 6 students have not met the math curriculum expectations on the EQAO tests. Reports such as "Closing the Numeracy Gap" in Ontario have also shed light on the lack of basic numeracy skills in both adults and children. This phenomenon has pushed math education to the forefront as a heavily debated and political issue.

On October 25, 2018, Premier Ford announced that all new educators must pass a math competency test to receive their certification. We believe this spotlight on teachers' knowledge rather than teacher practice is a band-aid solution to a complex problem. Through this project, we aim to support educators' practice rather than putting a focus on math knowledge.

(Alphonso, 2018; Orpwood & Brown, 2015; Alfieri et al., 2011)

There is a widespread belief that math instruction is either free exploration or "drill-and-kill". These are polarizing forms of instruction. We hope to address this misconception by providing a math instruction continuum based on a literature review.

A Continuum of Math Instruction

This mirrors Dr. Angela Pyle's Continuum of Play-based learning (Pyle & Danniels, 2017). The continuum allows us to illustrate the broad and diverse profiles of math instruction.

Below, the pedagogies are organized ranging from low-to-high structured activities. In Discovery Math, it is highly student-directed and low in teacher instruction contrasting Direct Instruction, where it is low in student autonomy and highly teacher-directed.

LOW ← **STRUCTURE** → **HIGH**

Discovery Math

(Kirschner et al., 2006; Kapur, 2014)

- Students are knowledge building by constructing their own solutions through exploration and problem solving
- Results in transferable skills and greater conceptual understanding

Learning through Examples

(Kapur, 2014)

- Students are provided with sample solutions and use metacognitive skills to discover their own problem solving methods
- Students replicate their methods in other math problems

Guided Math

(Alfieri et al., 2011)

- Learning is co-constructed between the teacher and students
- Teachers scaffold student discovery
- Students find the solution from given materials and guidelines

Direct Instruction

(Kirschner et al., 2006; Kapur, 2014)

- Teachers explain concepts and present students with procedural instructions
- Valuable in teaching concepts students may not learn organically
- Alternative strategies are not often sought

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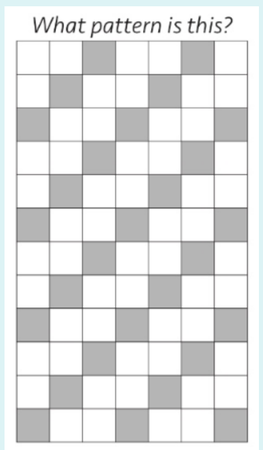
LESSONS ACROSS THE CONTINUUM

Discovery Math

Expectation: "create, identify, and extend numeric and geometric patterns, using a variety of tools" (p. 83)

Materials:
- Graph paper (/1 student)
- Markers
- Hundred chart



1. Students explore and share patterns they notice on a hundred chart
2. Show students the pattern below and ask "What pattern is this?"
3. Follow up by asking how their answer may change if the numbers on the grid increase by 2
4. Give students graph paper and markers to see what additional patterns they can create. Will they try grids of different sizes? Will the numbers they use vary? Will they overlap multiple patterns?
5. Invite students to share their findings in a discussion at the end of the class

(Adapted from YouCubed, 2018)

Learning through Examples

Expectation: "make predictions to growing and shrinking geometric and numeric patterns" (p.83)

Materials:
- Chart Paper (/1 per student)
- Sticky notes

1. A variety of open-ended patterning problems are displayed around the room
2. Students each develop a solution in small groups and display their solutions
3. After solutions are generated, students will walk from problem to problem, reading and comparing strategies
4. Students are provided additional opportunities to try new strategies

(Adapted from YouCubed, 2018)

Conclusion

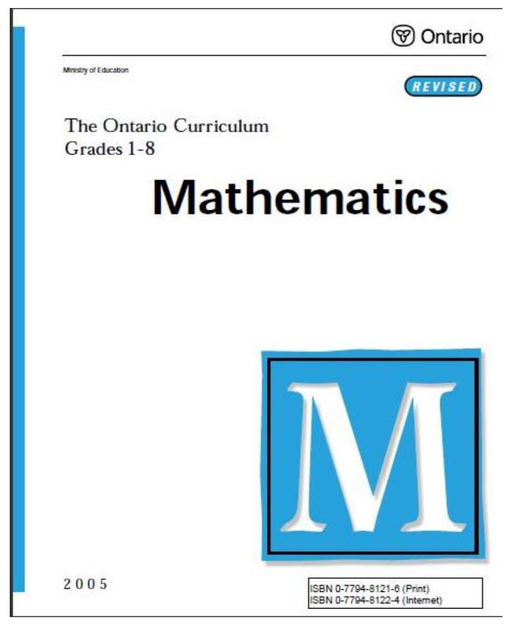
"When Doug Ford talks about getting rid of discovery math, what he's doing is he's perpetuating that math is taught in these dichotomous forms — either it's discovery or it's traditional."

Mary Reid, 2018

The Continuum of Math Instruction allows for a broadened scope of teacher practice. Each has its own merits and pitfalls. However, rather than focusing on one methodology, teachers need to differentiate their instruction by presenting multiple math-teaching strategies to meet the various learning needs of their students.

The following activities fall within the strand of Patterning and Algebra in Grade 5.

(MOE, 2005, p. 83)

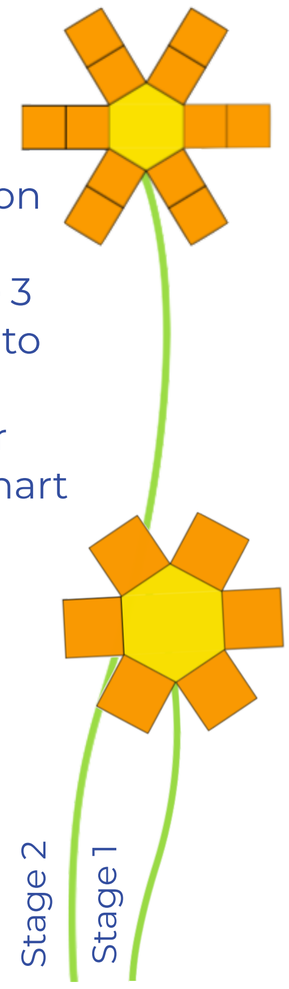


Guided Math

Expectation: "make predictions related to growing and shrinking geometric and numeric patterns" (p.83)

Materials:
- Thinking chart (/1 student)
- Various geometric shapes

1. Teacher shows example of a growing pattern on the board (Stage 1 & Stage 2)
2. Teacher prompts student discussion on Stage 3
3. Students discuss possible algebraic functions to match the growing pattern
4. Then independently, students can create their own geometric growing patterns, using the chart to fill in their algebraic functions



Thinking chart:

Stage Number	My Thinking	Total no. of pattern blocks
1		
2		
3		
4		

Adapted from (Markworth, 2012)

Direct Instruction

Expectation: "determine the missing number in equations involving + - x ÷ using a variety of tools and strategies" (p. 83)

Materials:
- Jump Math 5.2 "Introduction to Algebra" (p. 192)

1. Teachers tell students, "you will solve algebraic equations today. Equations are like the scales people use to weigh objects" (p. 192)
2. Teacher presents a series of problems (Question 1) and verbalizes the computation
3. Teacher reads the word problem aloud (Question 2) and verbalizes the procedure in creating and solving the equation

1. Solve the equations:

$5 + \square = 11$ $8 + \square = 15$ $3 + n = 13$ $7 + a = 13$

2. Write an equation to solve the problem:

There are 15 flowers in the flower-bed. Six are lilies. All the rest are peonies. How many peonies grow in the flower-bed?

(Adapted from Jump Math, 2009)