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WHAT DOES EFFECTIVE MATHEMATICS TEACHING LOOK LIKE AND THE EVIDENCE SUPPORTING IT?

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In this presentation we will consider:

- ✓ Perceptions about what mathematics: What is mathematics? What are common assumptions about how mathematics is taught?
- ✓ What pedagogy is driving updated/current practices in mathematics?
- ✓ How might some of these concepts and findings (about current pedagogy) manifest in today's mathematics classroom?
- ✓ Supporting Innovation: What can leaders do?
- ✓ Highlights of Ontario's numeracy results: PISA and EQAO
- ✓ *Small group discussions
- ✓ Wrap up: the power of the educator

*Perceptions about Mathematics

What is math?
What are my assumptions about how math is taught?

- ✓ A common misconception of the public is that mathematics is merely *a **set of procedures and rules to be drilled and memorized***.

- ✓ Traditionally, a lecture-based classroom that ***emphasizes the acquisition of skills/facts over the development of conceptual understanding*** has dominated the teaching of mathematics.
  - Since that *<u>was</u>* the predominant approach that much of the public experienced in the past when they were students in K-12 classrooms, many assume that pedagogy is still dominant today.

(Small, 2013; Van De Walle, 2013)

*Perceptions about Mathematics

What is math?

What are my assumptions about how math is taught?

- ✓ When they think of mathematics, most people think of ***computation with numbers*** .
  - They typically *don't think of open-ended questions and collaborative problem-solving processes* that are central to fostering students' conceptual understanding of mathematics.

(Small, 2013; Van De Walle, 2013)

Perceptions about Mathematics

What is math?
What are my assumptions about how math is taught?

- ✓ It is only natural that our ***current*** perceptions are based on our ***past*** experiences.
  - That is why **many educators struggle with understanding how to teach math in ways that they never experienced as a student.**
  - Disposition: If you didn't feel like math was your strength as a student in K-12, this **undermines your confidence** in your current teaching abilities.

(Small, 2013; Van De Walle, 2013)

Perceptions about Mathematics

What is math?
What are my assumptions about how math is taught?

- ✓ Many adults experienced, almost exclusively, **a strict linear approach to mathematical thinking and reasoning** in their K-12 years of education.
  - This is ***one*** reason why many educators still feel more comfortable perceiving math as a system of processes that ultimately lead to **"only one correct answer"** (where many may be possible), and further, that there is **a preferred strategy or algorithm to be used in order to arrive at that one correct destination/answer** (were a variety of different strategies or algorithms may have validity to the learner).

Perceptions about Mathematics

What is math?

What are my assumptions about how math is taught?

- **Example:** The philosophy of, "***there is only one correct answer***…" , although many answers are possible, is demonstrated in the following segment with these 4 educators. (video)

  http://www.youtube.com/watch?v=TIYMmbHiko8

- Obviously, there is more than one possible answer to the question, **"What is the best number?"**

Perceptions about Mathematics

What is math?

What are my assumptions about how math is taught?

- ✓ But: Are there some aspects of math that have ONLY ONE ANSWER, and if so, what role does this play in the acquisition of mathematics concepts?
- ✓ We do acknowledge that there is a necessity for **knowing some basic computations, drills, procedures, and symbols to the point of automaticity, where only one response/answer is possible,** in order to be able to successfully manage some processes or tasks in mathematics that are more complicated, or multi-faceted in nature.
- ✓ The mutual importance of knowing basic drills/procedures so that more complicated tasks can be performed is is also true in daily tasks, outside of math. For example, driving…


STOP


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*What pedagogy is driving updated/current practices in mathematics?

- We now recognize that students ***don't*** learn most ***mathematical concepts*** by simply practicing an *isolated skill over and over*.
  - The **shift away from a predominant focus on drill and repetition, towards a more balanced approach to instruction,** was informed by research indicating that students were able to apply mathematical rules without having a real understanding of the mathematical concepts underpinning the rules.
  - Performing a skill proficiently is *not* necessarily an indication that a **mathematical concept has been understood**. (… the same holds true in our *driving analogy*…)

(ref: Lawson, 2007; Mason, Buron, & Stacey, 2010; Small, 2013; Van De Walle, 2013)

What pedagogy is driving updated/current practices in mathematics?

- ✓ Instead of basing the value of a lesson **on *which skills were presented***, the teacher should be ***focusing on how the skills and concepts were developed.***

- ✓ Students need ***experiences that challenge their thinking and spark their interest and curiosity***. Mathematical thinking is ***not*** the product of practicing repetitive mathematical examples.

(ref: Mason, Buron, & Stacey, 2010; Small, 2013; Van De Walle, 2013)

What pedagogy is driving updated/current practices in mathematics?

- ✓ The mathematics classroom should provide students **with frequent opportunities** to develop each of the following mathematical processes and practices:
  - Problem-solving
  - Reasoning and proof
  - Communication
  - Connections
  - Multiple representations of a concept (i.e., manipulatives, different algorithms, etc.)

(ref: Mason, Buron, & Stacey, 2010; Small, 2013; Van De Walle, 2013)

What pedagogy is driving updated/current practices in mathematics?

Research indicates:

1. Students who are **encouraged to experiment with their own solutions to mathematical problems** develop a significantly deeper understanding of mathematics.
   - These same students are less prone to make errors than are their counterparts in traditional mathematics classrooms.

2. **Caution:** Most children will eventually learn to use traditional algorithms with some competence, **but in this process, *students often learn to ignore their own reasoning in favour of following the rules.***

(ref: Lawson, 2007)

What pedagogy is driving updated/current practices in mathematics?

Research indicates:

3. **Teaching practices that emphasize student interaction** improve students' *problem-solving and conceptual understanding* without loss of computational mastery.
   - Benefits increase further when **students share *reasoning* with one another**.

4. **Higher order questions** are correlated with increased student achievement, particularly *conceptual understanding*.

5. If left to their own devices, students will not necessarily engage in high-quality math-talk. **The teacher plays an important role in fostering high-quality math-talk.**

(ref: Bruce, 2007)

*How might some of these concepts and findings manifest in today's mathematics classroom?

Example: a discussion of open-ended questions and contextual considerations (video)

Items to consider:

1. Using Open questions:

- Be able to let a child take the material/idea to where he/she wants to take it, and not necessarily where you wanted it to go. *This supports the goal of developing independent thinkers.
- However, effectively using open questions is a learned skill. Not every teacher is comfortable using open questions, at first.
- A concern of teachers: Is it a productive use of time if the child goes to a place that you didn't anticipate?

(Ref: Small, 2013)

*How might some of these concepts and findings manifest in today's mathematics classroom?

Items to consider:

2. Contextual Factors:

- It is important to consider contextual variables when making teaching/learning-related decisions.
- However, the teacher's response to **contextual factors** relevant to the learning environment may help, or hinder, student learning and achievement.
- This reality is echoed in Marzano's (2009) caution about the role that context plays in his "high-yield" or "high probability" strategies. Even if context is considered, using a particular strategy does not *guarantee* improved student achievement, and in some cases, negative results may be reported.

How might some of these concepts and findings manifest in today's mathematics classroom?

Items to consider:

3. Balance:

- Use a variety of different approaches, ranging from teacher-directed to student directed.
- Use a variety of strategies (including a variety of manipulatives, etc.)
- **"Whatever you are, be different sometimes."**

(Ref: Marzano, 2009; Small, 2013)

How might some of these concepts and findings manifest in today's mathematics classroom?

Implementing Updated Practices: challenges facing teachers

- ✓ They are teaching mathematics in ways **they did not experience as students.**
- ✓ They may have **discomfort with their own mathematics knowledge.**
- ✓ There may be a **lack of sustained professional development** opportunities.
- ✓ There is a greater requirement for **facilitation skills and attention to classroom dynamics.**
- ✓ They may encounter a **lack of time**, especially in light of curricular demands.

(Ref: Bruce, 2007)

Supporting Innovative Approaches

WHAT CAN LEADERS DO TO SUPPORT TEACHERS' COMMITMENT TO, AND SUCCESS WITH, INNOVATIVE APPROACHES?

Supporting Innovation

- ✓ Many mathematics teachers are implementing strategies that are relatively new to their repertoire, and may also be **outside of their comfort zone.**

- ✓ Therefore, it is critical that leadership provides targeted support to teachers in order to promote the optimal environment for supporting innovative practices.

(Ref: Carter & Alfred, 1999; Fortune, 2013; Hoy & Miskel, 2008; Leithwood, 1999)

Supporting Innovation

- ✓ Various factors affecting the quality of teachers' engagement and participation in innovative practices **can be influenced by leadership practices.**

- ✓ Recommended leadership strategies to optimally support innovation include **ones that support positive context beliefs and positive capacity beliefs**.

(Ref: Carter & Alfred, 1999; Fortune, 2013; Hoy & Miskel, 2008; Leithwood, 1999)

Supporting Innovation

Promoting Positive Capacity and Context Beliefs

1. **Understanding the Fundamentals**

- ✓ Public access to, and the wide-spread distribution of, accountability measures, such as our Gr. 3, 6, and 9 numeracy results can garner **compliance** to try or use innovative strategies in the classroom.

- ✓ However, for **authentic faculty buy-in**, teachers need to see the benefits of the innovative practices in relation to student learning.

(Ref: Carter & Alfred, 1999; Fortune, 2013; Hoy & Miskel, 2008; Leithwood, 1999)

Supporting Innovation

Promoting Positive Capacity and Context Beliefs

- If teachers **personally experience and/or witness the benefits of innovative approaches,** such as open-ended tasks, or the use of manipulatives to foster student understanding, then they will **more readily see value in the new approaches, and engage in them more willingly.**

- Understanding the fundamentals means **that teachers see how the innovative practices align with valued programmatic goals.**

(Ref: Carter & Alfred, 1999; Fortune, 2013; Hoy & Miskel, 2008; Leithwood, 1999)

Supporting Innovation

Promoting Positive Capacity and Context Beliefs

2. Identify Change Champions

- ✓ This involves leaders identifying local (school level) change champions to lead change and serve as a **readily accessible resource/mentor** for teachers on site.

- ✓ Teachers need the opportunity to connect with these local stakeholders and have **opportunities for dialogue** with them.

(Ref: Carter & Alfred, 1999; Fortune, 2013; Hoy & Miskel, 2008; Leithwood, 1999)

Supporting Innovation

Promoting Positive Capacity and Context Beliefs

- ✓ District/Regional and Provincial level change champions are also an essential element of **promoting greater understanding of innovative practices, are a source of support for local implementers, and also serve as a source of inspiration when best practices are shared.**

- ✓ Often change champions facilitate teacher access to **timely and important information** which supports individual efforts.

(Ref: Carter & Alfred, 1999; Fortune, 2013; Hoy & Miskel, 2008; Leithwood, 1999)

Supporting Innovation

Promoting Positive Capacity and Context Beliefs

3. **Providing human and material support**
   - ✓ Facilitate access to worthwhile **professional development** opportunities that promote **training** around the specific skills necessary to engage in innovative practices.
   - ✓ Make available appropriate **material resources**, as needs present.

(Ref: Carter & Alfred, 1999; Fortune, 2013; Hoy & Miskel, 2008; Leithwood, 1999)

Supporting Innovation

Promoting Positive Capacity and Context Beliefs

- ✓ Establish a **communication infrastructure** where feedback about both needs and successes can be exchanged.
- ✓ Teacher's involvement in **shared decision-making processes** (i.e., around action plans, and the allocation of material support, timelines, etc.) fosters collective ownership of outcomes necessary to keep the innovation moving forward.

(Ref: Carter & Alfred, 1999; Fortune, 2013; Hoy & Miskel, 2008; Leithwood, 1999)

Supporting Innovation

Promoting Positive Capacity and Context Beliefs

Collaborative Inquiry:

- ✓ **Teachers work together** (collaborate) to engage in the 4-sate reiterative cycle:
  - Reflect: determine focus and methods
  - Action: record outcomes, evaluate
  - Build experiential knowledge
  - Reflect: re-frame, amend inquiry
- ✓ Teacher isolation and individualistic approaches to teaching are the norms; collaborative inquiry runs against these prevailing norms, and needs to be supported and encouraged
- ✓ **The benefits of collaborative inquiry: it supports innovation**
  - It helps with understanding the fundamentals
  - Change champions : it creates opportunities for dialogue
  - It fosters a framework for human and material support

How are we doing?

HIGHLIGHTS OF ONTARIO STUDENT RESULTS IN NUMERACY

Programme for International Student Assessment

PISA 2012 results are in!

- ✓ Ontario students' math performance is on the **decline**.
- ✓ The overall average math score for Ontario students has steadily **decreased by 16 points over the past nine years**, from an average score of 530 points in 2003 to 514 points in 2012.
- ✓ Ontario students' math achievement **matched the Canadian average** (which is also on the decline) on both overall and in the mathematical sub-skills evaluated.
- ✓ Ontario **boys** (520 points) performed better than Ontario **girls** (509 points).

(Ref: EQAO, December 3, 2013)

EQAO

2012-2013 Results at a Glance

Grade 9:

- Academic course: **84%** performed at or above the provincial standard
  - ✓ ***This is an increase of 7 percentage points (up from 77%) over the past 5 years**

- Applied course: **44%** performed at or above the provincial standard
  - ✓ ***This is an increase of 6 percentage points (up from 38%) over the past 5 years**

(Ref: EQAO, 2013)

EQAO

2012-2013 Results at a Glance

Grade 6:

- 57% of students performed at or above the provincial standard
  - ✓ ***This is a decrease of 6 percentage points (down from 63%) over the past 5 years**

Grade 3:

- 67% of students performed at or above the provincial standard
  - ✓ ***This is a decrease of 3 percentage points (down from 70%) over the past 5 years**

(Ref: EQAO, 2013)

Small Group Discussion…

Potential Discussion Questions:

1. How comfortable are mathematics educators, or are you, with approaches such as open-questions, collaborative inquiry, or investigative methods that are not linear?
2. How can we best address challenges that teachers face implementing updated/current practices?
3. What are your thoughts about our provincial results, either EQAO or PISA?
4. **Other questions generated at your table?**

I'll give you a 2 minute countdown to signify the end of this small group discussion activity.

Small Group Discussions

http://www.online-stopwatch.com/countdown-timer/

(*Countdown of the final 2 minutes*)

Presentation Wrap Up

FINAL THOUGHTS…

The Power of the Educator

- For the remainder of the day you'll be hearing presentations from a variety of true ***Change Champions***.
- **Change Champions** promote **greater understanding of innovative practices, and serve as a source of inspiration by sharing best practices and insights.**
- Research indicates that **the most important variables** in determining the climate of a classroom, which is the **learning environment for your students**, **are the teacher's verbal and nonverbal behaviours.** Educators have a powerful opportunity to serve as **change champions for their students.**
- Closing thought…

(Ref: Carter & Alfred, 1999; Levin, Nolan, Kerr, & Elliott, 2007)

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