Supporting and Revealing Student Learning in Math

The Student of Mystery Approach

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With grateful acknowledgement to the leadership of DSB/CDSB math facilitators and the commitment of participants in the EOSDN Regional Math Project

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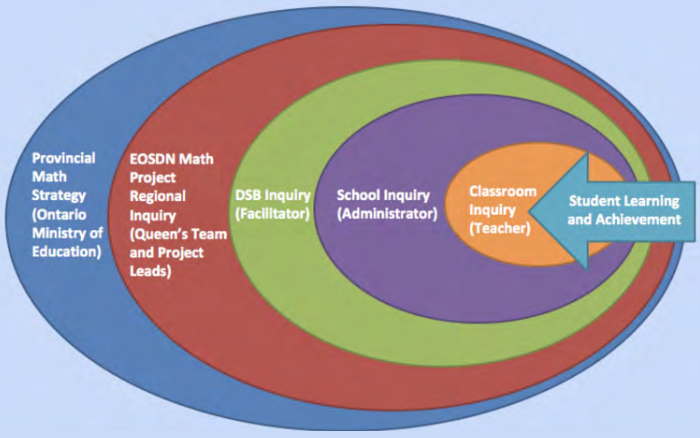
Our Context

The Eastern Ontario Staff Development Network, a consortium of Eastern Ontario District School Boards and the Faculty of Education at Queen's University, provides ongoing collaborative professional learning opportunities for administrators, teachers, and researchers in the region. Supported by funding from the Ontario Ministry of Education, EOSDN coordinated a six-year (2013-2019) regional mathematics study that aimed to enhance outcomes for students through professional discourse and research-informed instructional practices. Educators in various roles (classroom teachers, school support teachers, school administrators, district facilitators, and others) networked across the region and within their districts placing emphasis on building educator fluency with mathematical big ideas and processes for representing mathematical thinking. This work was supported by recognized experts in mathematics education, Queen's University researchers, Ministry of Education Student Achievement Officers, and educators with experience in mathematics, special education, technology, and school leadership. Beginning in 2016, the project purposefully incorporated the provincial priority of supporting students who struggle in mathematics and those with identified learning disabilities, through a whole-school approach. Educators leveraged asset-based learner profiles, responsive instruction, targeted accommodations, and assistive technology to support student learning in mathematics. Knowing the student first by adopting a SWST-like* stance and focusing on math fundamentals enabled greater precision in our work in the final three years of the project (2016-2019) and allowed participants to support and reveal the learning of students of mystery in math.

Nested Regional Inquiry Model

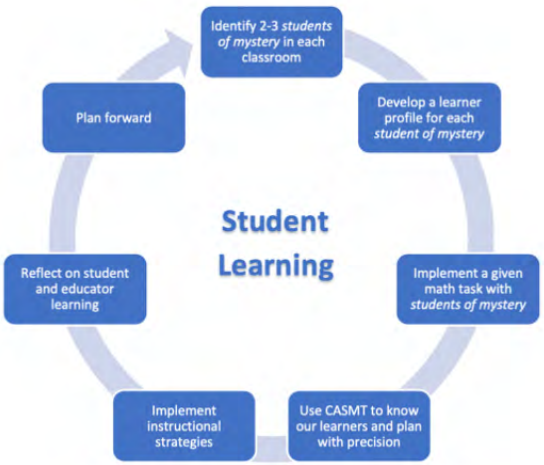
The nested regional inquiry model illustrates that authentic inquiry begins with knowing our students' strengths and needs. The questions classroom educators ask themselves are in response to specific student needs. Inquiries in district school boards (DSBs), the region, and province are developed to support the learning of students and their teachers in classrooms.



A SWST* (Student Work Study Teacher) studies the classroom experience of specific students to understand what assists their capacity to benefit from instruction. See Taouil 2019 or Ryerson 2018

Student of Mystery Inquiry Question

This monograph describes a professional collaboration cycle for addressing learning needs of students not yet benefitting from mathematics instruction – students of mystery. An inquiry question provides a focus for educators: How might evidence of student learning inform instructional and leadership moves in order to support the development of fundamental math concepts and skills among our students of mystery? The approaches taken enhanced math teaching and learning in classrooms that engaged in the EOSDN math project.



Cycle of Professional Collaboration: The Student of Mystery Approach

Our cycle of professional collaboration (the Student of Mystery Approach) entails five phases. Each phase is described briefly then followed by specific actions for practice in the classroom and in professional collaboration with colleagues.

1. Start with Knowing the Students of Mystery

In every classroom there are students not yet responding to instruction. These students of mystery challenge our sense of professional efficacy as our best attempts to assist them seem not to be effective. Teacher participants in the EOSDN math project found it helpful to develop a learner profile for these students and to collaborate with colleagues to analyze student strengths and needs. The profile provided insights into student interests, motivations, and learning preferences, and for targeting strategies to build on student strengths.

What does this mean for my practice?

Choose 2-3 students of mystery and develop learner profiles.
Collaborate with colleagues about Universal Design for Learning and differentiation.

In the classroom:

- think of students who are not yet meeting with success in mathematics; choose two or three to be your students of mystery
- for each of these students write down what you already know about their learning strengths, needs, preferences, interests, friends, what type of activity engages them, what tools do they use, and when they are at their best
- review the OSRs, achievement data, and special education history if applicable
- seek the perspectives of others who know the students and the students themselves
- list questions/wonderings that you have about these students
- organize the information into a learner profile for each student using the framework recommended by your board or in the ministry document Learning for All
- consider the learner profile a living document

My approach to assessment for my students of mystery is slightly different. I have spent more time analyzing the "why" behind their completed tasks. I have also spent time with them to better understand their thinking and their procedures. I take their oral explanation into consideration as many of them are better able to explain orally.
~Classroom Teacher

In professional collaboration:

- meet with colleagues and share information and perspectives about the students of mystery that each of you have chosen
- consider ways to engage these students – how to draw each of them into the learning through their particular interests and preferences
- consider multiple means of representation, different ways for these students to access and process information
- consider student strengths and alternative means by which they could demonstrate and express what they know and understand
- discuss classroom instructional moves that have been tried, including adjustments to content, process, product, and environment (differentiation)
- consider instructional approaches, strategies, tools, and resources that may benefit each of the students

By focusing on students of mystery, we have been able to identify gaps and implement strategies to address them, which has put the focus on clear learning goals and responsive instruction.
~School Administrator

2. Have Students of Mystery Complete a Math Task

Careful analysis of student mathematical thinking provides information that enables teachers to respond with precision to support the learner in moving forward. Analysis of student response to an initial math task provides baseline data about strategies the student uses to address a problem and areas of struggle. The student's approach to the problem can be matched to a stage of conceptual understanding on a mathematical developmental continuum, providing the teacher with clarity about next steps and instructional strategies that build on student strengths.

What does this mean for my practice?

Select an appropriate math task and observe the students of mystery working on it. Collaborate with colleagues to analyze student mathematical thinking (CASMT).

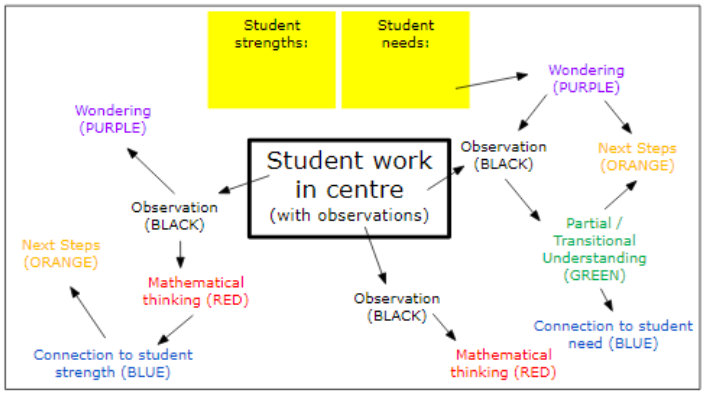
In the classroom:

- select a math task that focuses on understanding an aspect of fundamental math content
- ensure that the task will provide appropriate challenge but is accessible for the student
- do the task yourself using different strategies students might use so that you are prepared to notice and name what students do
- refer to a developmental continuum to consider how different strategies represent different mathematical understanding related to the math problem
- have the student complete the task independently making sure that appropriate math manipulatives and tools are available for the student to use
- read the question to the student and provide clarification as needed
- observe the student at work and record what the student says and does, including think alouds and gestures and/or mathematical actions with concrete or digital tools
- the goal is to understand student thinking, so it is appropriate to engage with the student about the thinking: "I noticed you did…tell me about your thinking"
- resist assisting the student with this task; offer no prompts, suggestions, or solutions

In professional collaboration:

- with colleagues use the Collaborative Analysis of Student Math Thinking (CASMT) protocol to analyze student written responses to the math task and your observations of the student at work on the task:
- observations (in black)
- mathematical thinking that is evident (in red)
- partial or transitional understandings evident (in green)
- connections to strengths or needs of the student (in blue)
- wonderings you have (in purple)
- next steps for this student (in orange)
- with colleagues think about each student's response in relation to a math developmental continuum – where is the learner at, where do they need to go next, and what support will help them get there
- add any new understandings to the learner profile

CASMT Visual Map



CASMT is a research-based approach that enables educators to apply their combined professional wisdom and experience to the challenge of determining how a student is attempting to make meaning of key mathematical concepts and skills. Using the protocol provides visible insight into student thinking and a basis for instructional decision-making.

See Colton, Langer, & Goff (2015) to learn more about the collaborative analysis of student learning.

3. Implement Strategies to Support the Learning of Students of Mystery

Making sense of math can be a challenge for students. Students build mathematical knowledge and understanding (conceptual schema) by working on math problems: thinking and talking about approaches to a problem; choosing how to represent, explain, and apply their mathematical thinking; and by making connections among mathematical ideas. When educators make learning visible by explicitly noticing and naming the math ideas and strategies demonstrated by the student, the student is better able to access and apply new understandings in the future.

What does this mean for my practice?

Implement instructional strategies and document impact on students of mystery. Collaborate with colleagues to gauge the impact of educator moves on student learning.

In the classroom:

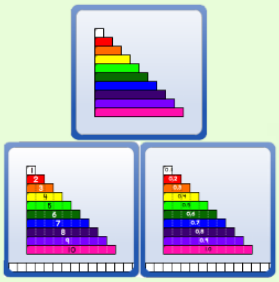
- continue to have each student of mystery work on problems related to the selected aspect of fundamental math content
- when choosing problems, consider the student's mathematical thinking as revealed through CASMT and the developmental continuum
- select instructional strategies and learning tools in light of the motivations, strengths, and learning preferences shown in the learner profile
- be attentive to your "educator moves" by noting how the student responds to different means of engagement, types of instruction, and interactions
- engage the student in "math talk" and intervene (provide instruction) as appropriate to support their learning
- be attentive to evidence that the student provides about their understanding of math concepts and skills
- continue to use the developmental continuum to consider any progress the student in making in how they apply their mathematical understanding

In professional collaboration:

- with colleagues, consider resource materials that might inform your instructional practices in mathematics or provide deeper understanding of student learning needs
- with colleagues, review notes about how your students of mystery are responding to the strategies and tools selected, considering the following questions:
  - » in what ways do their particular interests and preferences inform your instructional strategies
  - » what are your observations about how students of mystery access and process mathematical ideas
  - » what means of demonstration, representation and expression work best for these students
  - » what tools and resources are helpful
  - » which instructional moves have greatest impact
  - » what adjustments to content, process, product and environment (differentiation) are helpful
  - » how are you using the developmental continuum

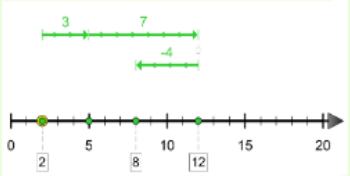
Simple Mathematical Tools

Relational Rods+



www.mathies.ca

Number Line



Potential Collaborators

- DSB/CDSB Math Lead
- School Math Lead
- Grade Partner
- Special Education Teacher
- School Administrator
- Student Achievement Officer

I really enjoyed being a part of this project. I feel that it benefited my students of mystery, and I could see their progress with the strategies we targeted. Our math lead did a great job of guiding us through this project. I look forward to using the strategies I learned throughout this project in my future teaching.

~Classroom Teacher

4. Have Students of Mystery Complete a Second Math Task

Careful analysis of student mathematical thinking on a second math task provides precise information about the approaches the student used to address a problem and progress being made on a mathematical developmental continuum. This assists educators in gauging the impact of selected instructional strategies and determining next steps for building on student strengths. Documentation of precise teacher moves and impact on student thinking builds collaborative professional wisdom.

What does this mean for my practice?

Select an appropriate math task and observe the students of mystery working on it. Collaborate with colleagues to analyze student mathematical thinking (CASMT).

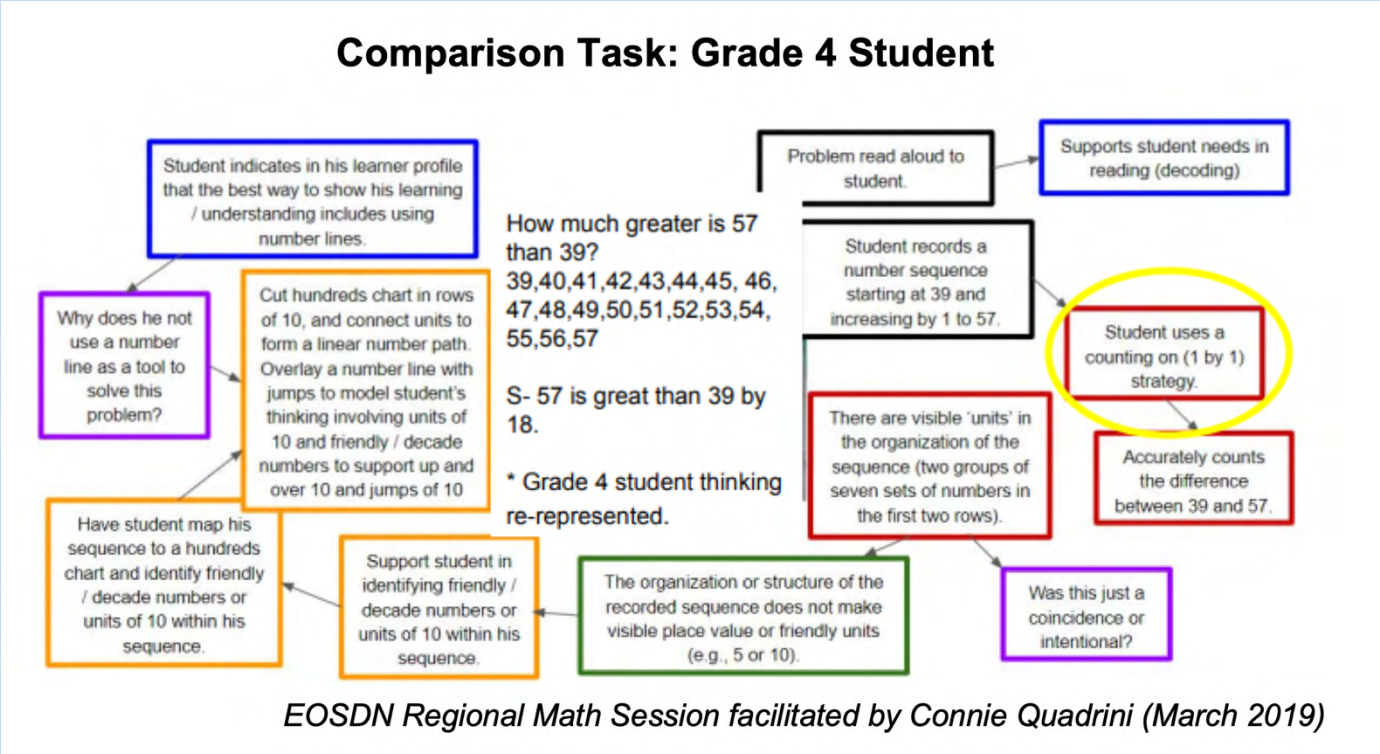
In the classroom:

- select a math task that is similar to the first task and addresses the same concept
- do the task yourself using different strategies students might use in light of a developmental continuum of mathematical understanding
- have the student complete the task independently using the protocol described for the first math task
- observe the student at work, record what the student says and does, inquire into their mathematical thinking but offer no assistance with the solution

In professional collaboration:

- with colleagues, use the CASMT protocol to analyze student written responses to the math task and your observations of the student at work on the task
- with colleagues, consider each student's response in relation to a mathematical developmental continuum – where is the learner at and how does student thinking during the second task compare to the first task
- document your findings regarding the impact of teacher moves on student thinking and development
- with colleagues, consider where the student needs to go next and what support will help them get there

A Student Work Sample Analyzed Using CASMT



EOSDN Regional Math Session facilitated by Connie Quadrini (March 2019)

5. Refine the Learner Profile and Plan Forward with Precision

Student learning is at the center of all we do as professionals. Research and practice tell us that targeted teacher moves have the greatest impact on student outcomes. Educator participants in the EOSDN math study report that using evidence from collaborative analysis of student thinking (CASMT) and referencing a developmental continuum is key to informing precision in instruction. They also confirm that working collaboratively to build collective capacity to address the learning needs of students of mystery is an effective practice.

What does this mean for my practice?

Use the evidence from practice to inform next steps in supporting the students of mystery. Collaborate with colleagues to celebrate and continue to build professional capacity.

In the classroom:

- review the student learner profile and add any new information and understanding you have
- consider evidence of impact of instructional strategies and teacher moves on how students of mystery access, process, and share mathematical ideas
- consider which adjustments to content, process, product, and environment, and which learning tools were helpful to the student
- use your understanding of the mathematical development continuum and evidence of student thinking from CASMT and classroom observation to assist in determining where the student is at and where they need to go next
- plan next steps for the student learning

In professional collaboration:

- with colleagues, identify with precision the instructional moves that make a difference for the students of mystery
- with colleagues, determine which professional resources and classroom resources/tools you find are most impactful to classroom teaching and learning
- name and celebrate the wisdom that comes from collaborative professional practice and share your findings with other colleagues
- consider the next steps for team professional learning in light of the next steps you identify in the learning of your students of mystery
- continue to build team understanding of the mathematical developmental continuum

Classroom educators most valued:

- Using a developmental continuum to support students' conceptual understanding of math fundamentals
- Analyzing student work purposefully (e.g., CASMT approach)
- Using evidence from analysis of student work to inform next steps in instruction

School and system educators most valued:

- Prioritizing opportunities for collective capacity-building among school teams
- Promoting shared leadership among school teams
- Establishing trust and open communication among school teams

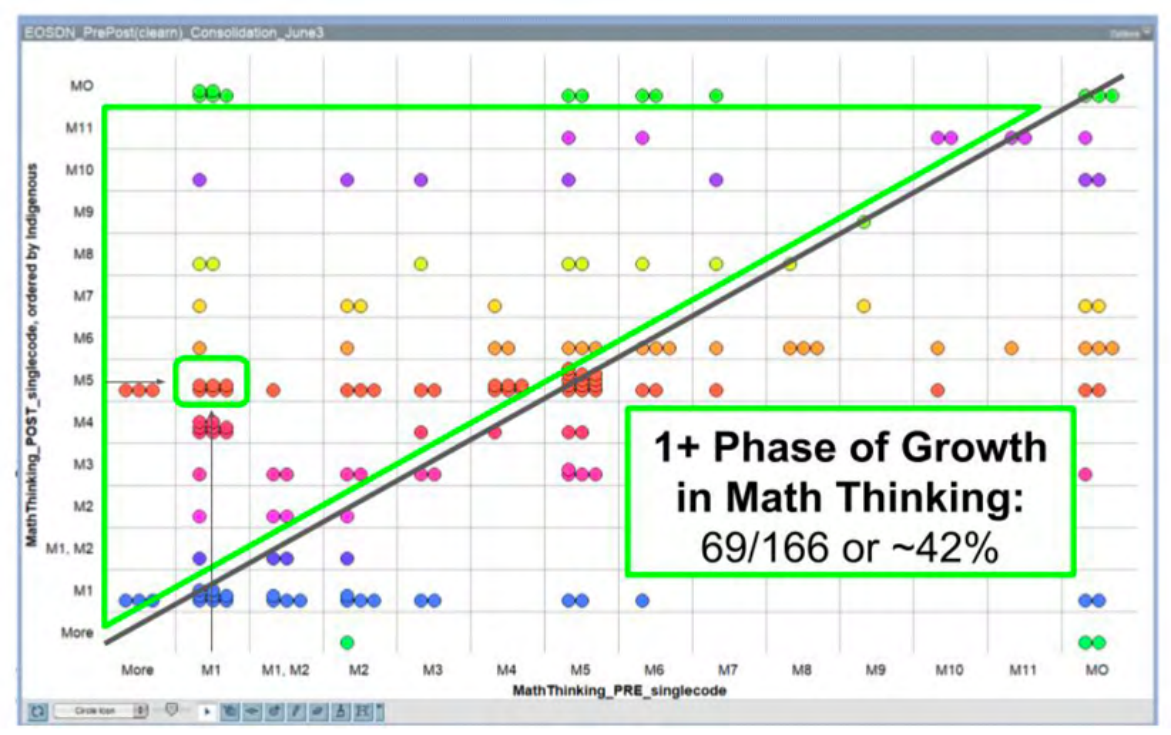
Educators are excited and immersed in collaborating with one another. They are using the subitizing continuum and sharing it with their colleagues who did not participate in EOSDN. They are speaking the same language and are choosing appropriate intentional moves based on assessment tools.
~School Administrator

Regional Growth in Students' Math Thinking

During year 6 of the EOSDN math project, all students of mystery identified by school teams across the region (N = 228; 2 students per each of 114 classroom teachers) completed common pre- and post-tasks at the beginning and end of a three month period. School teams, with the support of their district facilitators, used the Collaborative Analysis of Student Math Thinking (CASMT) protocol to analyze phases of students' thinking evident in pre- and post-task solutions. In total, 166 complete sets of pre- and post-tasks were collected regionally, representing 72.8% of students of mystery. Among these students, a majority were in the Primary division (n = 102, 61.5%), while 53 were Junior (31.9%) and 11 were Intermediate (6.6%). Fourteen of these students of mystery (8.4%) had formally identified learning disabilities.

Forty-two percent of students of mystery (n = 69) demonstrated an increase of one or more phases of growth in their math thinking in relation to the developmental continuum.Thirty-four students of mystery (20%) showed no change in their math thinking, and 32 (19%) showed some regression in their math thinking in relation to the developmental continuum. Given the short timeline (February-May 2019) and identified learning needs among students of mystery, these overall results are encouraging and highlight the benefits of educators using the CASMT protocol in conjunction with developmental continua of students' math thinking to precisely assess and support math learning among students of mystery. Using the CASMT protocol and developmental continua not only elucidated growth in 42% of students' math thinking, educators using these approaches reported having better understanding of student responses and the precise instructional steps needed for students to make progress in their math thinking.

Growth in Math Thinking Among Students of Mystery

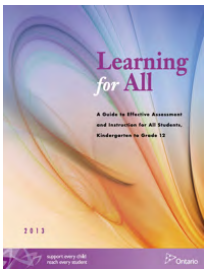


Students are better able to think flexibly about problems. They are learning to consider the numbers and how they are related, rather than focusing on key words. They are learning that different strategies work better, depending on the numbers and the situation. They are learning about how mathematical tools and models can support their thinking.

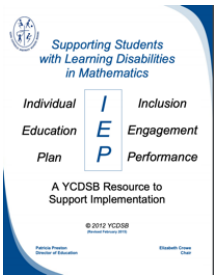
~District Facilitator

Resources Supporting Our Learning

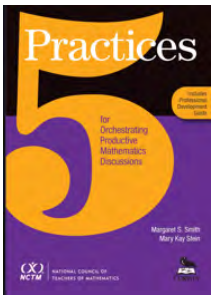
Ontario Mathematics Curriculum and Focusing on the Fundamentals of Math, Grades 1-8
(Ontario Ministry of Education)



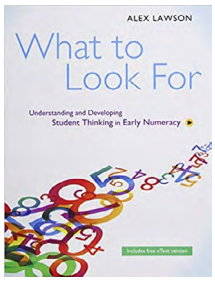
Learning for All: A Guide to Effective Assessment and Instruction for All Students, Kindergarten to Grade 12
(Ontario Ministry of Education, 2013)



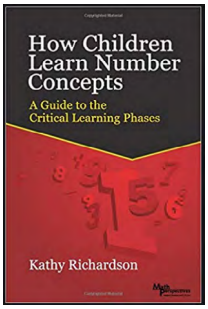
Supporting Students with Learning Disabilities in Mathematics
(York Catholic DSB, 2012)



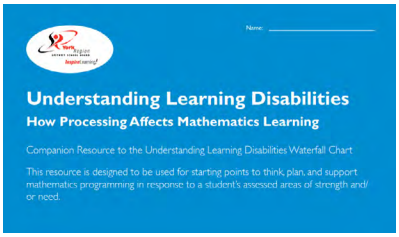
5 Practices for Orchestrating Productive Mathematics Discussions
(Margaret S. Smith & Mary Kay Stein, 2011)



What to Look For - Understanding and Developing Student Thinking in Early Numeracy
(Alex Lawson, 2015)



How Children Learn Number Concepts -
A Guide to the Critical Learning Phases
(Kathy Richardson, 2012)



Understanding Learning Disabilities:
How Processing Affects Mathematics Learning
(York Region DSB, 2017)

EduGAINS
Math resources to support content knowledge and use of technology to support student learning

As professionals, we have focused on curriculum content and processes, on research into math teaching and learning, on strategies for assessment and instruction, on gathering and analyzing data – all to build educator fluency so that we can hear and respond with precision to the student voice.

~Project Director