MATH TASK FORCE 2.0

GECDSB REPORT 2019

GREATER ESSEX COUNTY DISTRICT SCHOOL BOARD

BUILDING TOMORROW TOGETHER. EVERY LEARNER, EVERY DAY.

ACKNOWLEDGEMENTS

This report is the culminating effort of a team of extremely talented and dedicated individuals. This work would have not been possible without the commitment, persistence, expertise and extraordinary passion of the Math Task Force 2.0 Committee. Each member has brought a unique perspective to this process and their collective contributions and efforts have continued to forge a path for the teaching and learning of mathematics within the Greater Essex County District School Board.

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In addition to the community experts and staff that worked with the committee, we also had the pleasure of professional critical friends. We would like to sincerely thank the following educational leaders for their time and critical feedback: Dr. Hyman Bass, University of Michigan and Dr. Cathy Bruce, Trent University.

MATH TASK FORCE 2.0

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GECDSB Math Task Force
Project Overview

In the fall of 2014, the Greater Essex County District School Board released *A Vision for Mathematics*, which set the aims of mathematics education for the GECDSB. This document was developed from an extensive review of research, and grounded in the principles of the Full-Day Early Learning—Kindergarten program and the Ontario Mathematics Curricula for grades 1-8, 9 & 10, and 11 & 12. It was instrumental in extending the discourse of mathematics education toward a comprehensive definition of mathematical proficiency.

> ***"The GECDSB provides mathematics education that engages and empowers students through collaboration, communication, inquiry, critical thinking and problem-solving, to support each student's learning and nurture a positive attitude towards mathematics."***
> GECDSB: A Vision for Mathematics

Conversations about mathematics teaching and learning continued, and greater attention was placed on how to best support student achievement in mathematics. In the spring of 2015, the Trustees of the Greater Essex County District School Board approved a motion for the formation of a "Math Task Force." The purpose of this Task Force was to examine the practices of mathematics teaching and learning from multiple perspectives within the GECDSB, and to advise Senior Administration and the Board of Trustees as to how best to support future planning in the area of mathematical teaching and learning.

The GECDSB Math Task Force is comprised of a diverse group of individuals including Trustees, classroom educators, school administrators, parent/guardian representatives, central office staff, university and community experts, and university students. In addition to the committee members, external experts from the field of education provided input as "critical friends" of the cooperative work.

The Math Task Force reconvened in January of 2019 to revisit the considerations set forth by the first Math Task Force Report. The goal of Math Task Force 2.0 is to consider the relevance and level of implementation of the 14 original considerations. This group engaged in dialogue, school level observation, and sought feedback from stakeholders and experts to inform next steps and revisions to the existing considerations.

A VISION FOR MATHEMATICS

"The GECDSB provides mathematics education that engages and empowers students through collaboration, communication, inquiry, critical thinking and problem-solving, to support each student's learning and nurture a positive attitude towards mathematics."

Whenever we strive to improve in any way, a vision of what that improvement might be is essential. We need to know what we are working towards and why that is important. We also need to know how we plan to reach that vision.

This vision has been developed specifically by and for the Greater Essex County District School Board through consultations with a wide variety of stakeholders including elementary and secondary teachers and administrators, Curriculum and Program staff, Student Success, and Special Education departments. The intent of this vision, and the related strategies and approaches to mathematics teaching and learning, is to support schools and educators as they reflect on the needs of their students and how they will address their needs as part of their ongoing School Improvement Plans.

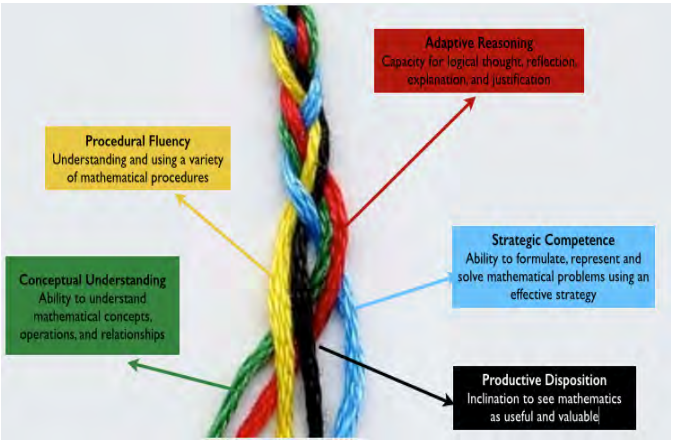
Within this vision there are various responsibilities we assume. As a school board, we believe our responsibilities are to create conditions for mathematics learning:

- where knowledgeable educators integrate instruction and assessment;
- where educators and administrators are committed to ongoing learning about mathematics and mathematics instruction;
- where learning environments nurture positive attitudes towards mathematics; and
- where all students have opportunities and support to learn significant mathematics with depth and understanding.

It is the belief of the board that where this vision is actively pursued, and where these responsibilities are met, students' achievement in mathematics will increase.

A Picture of Mathematical Literacy

What is Mathematical Literacy?



Conceptual Understanding is the ability to understand mathematical concepts, operations, and relationships.

Procedural Fluency is the skill in carrying out procedures flexibly, accurately, and efficiently, and knowing when the procedures should be applied.

Adaptive Reasoning is the capacity for logical thought, reflection, explanation, and justification.

Strategic Competence is the ability to formulate, represent and solve mathematical problems using an effective strategy.

Productive Disposition is the inclination to see mathematics as useful and valuable.

In order to begin any conversation around improving mathematics, we need to share a common understanding of mathematical literacy.

For the complete version of the GECDSB: A Vision for Mathematics (See Appendix A).

LITERATURE REVIEW

Principles to Actions is a research-based resource published by the National Council of Teachers of Mathematics (NCTM) that aims to create equity within the realm of mathematics teaching and learning. In an effort to move away from "pockets of excellence." It is the belief that the Mathematics Teaching Practices outlined by this research will move towards "systemic excellence," where all students are mathematically proficient and they can access mathematics and achieve high levels.

The eight Mathematics Teaching Practices outlined below are a framework "for strengthening the teaching and learning of mathematics" (NCTM, 2014).

Mathematics Teaching Practices
Establish mathematics goals to focus learning. Effective teaching of mathematics establishes clear goals for the mathematics that students are learning, situates goals within learning progressions, and uses the goals to guide instructional decisions.
Implement tasks that promote reasoning and problem solving. Effective teaching of mathematics engages students in solving and discussing tasks that promote mathematical reasoning and problem solving and allow multiple entry points and varied solution strategies.
Use and connect mathematical representations. Effective teaching of mathematics engages students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem solving.
Facilitate meaningful mathematical discourse. Effective teaching of mathematics facilitates discourse among students to build shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments.
Pose purposeful questions. Effective teaching of mathematics uses purposeful questions to assess and advance students' reasoning and sense making about important mathematical ideas and relationships.
Build procedural fluency from conceptual understanding. Effective teaching of mathematics builds fluency with procedures on a foundation of conceptual understanding so that students, over time, become skillful in using procedures flexibly as they solve contextual and mathematical problems.
Support productive struggle in learning mathematics. Effective teaching of mathematics consistently provides students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas and relationships.
Elicit and use evidence of student thinking. Effective teaching of mathematics uses evidence of student thinking to assess progress toward mathematical understanding and to adjust instruction continually in ways that support and extend learning.

(NCTM, 2014)

Principles to Actions is rooted in the five mathematical proficiencies. This research states: "conceptual understanding (i.e., the comprehension and connection of concepts, operations, and relations) establishes the foundation, and is necessary, for developing procedural fluency (i.e., the meaningful and flexible use of procedures to solve problems)" (NCTM, 2014). The National Council of Teachers of Mathematics support a shift away from "too much focus… on learning procedures without any connection to meaning, understanding, or the applications that require these procedures" (NCTM, 2014).

An obstacle facing this research is cultural beliefs about mathematics. Many teachers and parents/guardians still believe that students will learn best the way that they were taught. The

traditional model being, the teacher provides direct instruction (modelling the strategy or procedure on the board), students mimic the strategy and then have an opportunity to practice. In contrast, *Principles to Actions* promotes a learning environment where teachers select a specific task that will highlight certain key mathematical concepts or connections. Teachers support students as they work collaboratively work using a variety of tools and representations. Teachers prompt students and ask questions that reveal links between different representations and examine students' mathematical reasoning through conversation and observation. Through the consolidation, students have an opportunity to analyze and compare student strategies. Teachers also use the consolidation to derive meaning from the task, name the learning and extend student thinking by revealing key relationships. Through discourse, students are able to make conjectures, draw conclusions and ask questions that will propel their learning forward (NCTM, 2014).

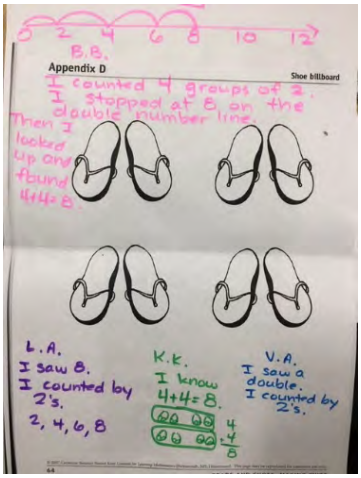
"This framework offers educators within schools and across districts a common lens for collectively moving toward improved instructional practice and for supporting one another in becoming skilled at teaching in ways that matter for ensuring successful mathematics learning for all students" (NCTM, 2014).

Examples of the Eight Mathematics Teaching Practices in Action from Across GECDSB

Establish Mathematics Learning Goals to Focus Learning

In a grade one class, students were working on their ability to automatize doubles and near doubles as an addition strategy. The teacher connected this learning to the overall expectation for number sense, which states: "solve problems involving the addition and subtraction of single-digit whole numbers, using a variety of strategies." There was a clear learning objective for this lesson: *students will develop the ability to subitize doubles and near doubles*. She knew that students would need to rely on their prior knowledge in order to access this task, which included skip counting by twos and unitizing (creating groups of).

From Cathy Fosnot's *Context for Learning Mathematics* unit "Beads and Shoes, Making Twos", the teacher showed a series of "billboards" with shoes. Students saw 4 pairs of shoes and stated, "I know that there are 8 shoes because 2 plus 2 is 4, and 4 plus 4 is 8". "I see 2, 4, 6, 8 shoes". Another student stated, "I see four groups of 2". "I see 4, and another 4, that's 8."



When the teacher presented a billboard with seven, a student said, "I subitized 6 shoes, and then 1 more". "I saw a near double, I saw a double (3 and 3) and 1 more without a pair, that makes seven."

Implement tasks that promote reasoning and problem solving

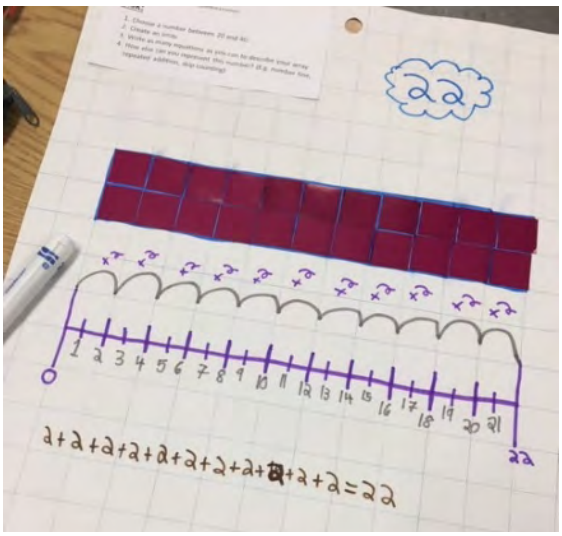
In a grade 7 class, students were engaged in a math task that promoted mathematical reasoning and problem solving. This task was presented visually. This task was a cross-strand task (Number Sense [fractional thinking], Geometry, and Patterning), and was connected to expectations in Art and Mathematics.
Throughout this task, it was noted those students:
-asked clarifying questions to more deeply understand different thinking e.g., "It's all mental math, why do you need to count it?";
-freely used their voice to express understanding and opinions about the solution;
-shared a range of ideas and possible solutions; and,
-described and justified their mathematical solutions to convince their partners.

Use and connect mathematical representations

In a grade 4 classroom, students were observed connecting an array model to a variety of number sentences. Students were asked to represent a number between 20 and 40 using an array. Students were given the choice between square tiles and square stickers to create their array. Students began writing a variety of number sentences using different operations to describe their number. By making connections to the array models, students were able to explore and communicate the following mathematical ideas:

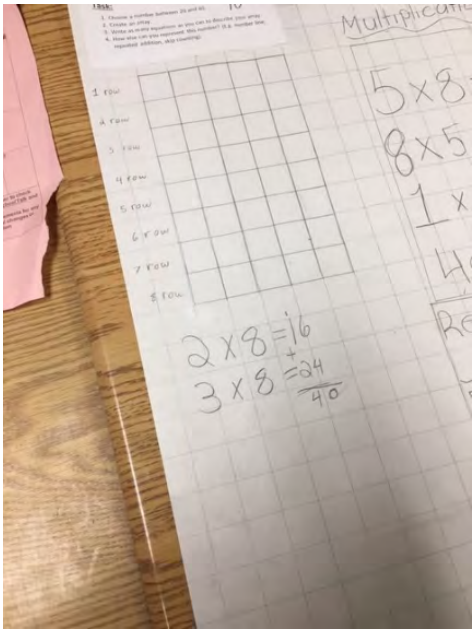
- relating repeated addition to multiplication;
- making connections to repeated addition on the number line;
- seeing multiplication as groups of;
- exploring the commutative property of multiplication;
- seeing partial products;
- relating multiplication and division; and,
- exploring both partitive and quotative division.

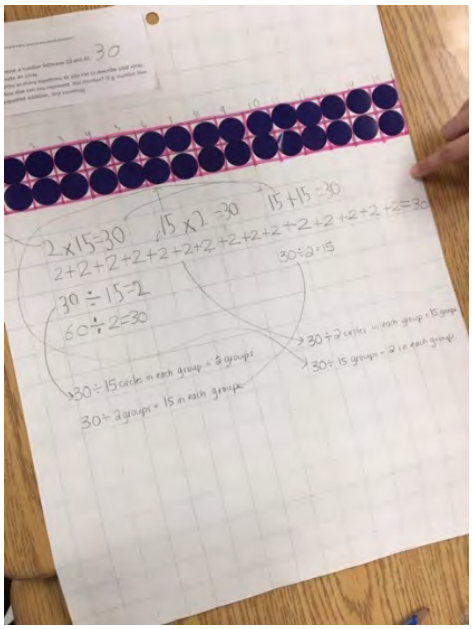
"Our number is 30. In this array, I see 12 x 2 + 6. I also see 5 groups of 6 and 6 groups of 5. We also split the array, see here, 2 groups of 5 plus 4 groups of 5 is 10 + 20 and that equals 30. I also showed on the number line over here 15 + 15, and that's the same as 2 groups of 15."



"Our number is 22. That is the same as skip counting by two 11 times. See, we showed it here on the number line."

"The number that we chose is 40. We wrote all of these different multiplication sentences. 5 x 8, 8 x 5, 1 x 40, 40 x 1. But then we realized we could split the array and write a bunch more. This one is 2 x 8 + 3 x 8 = 40."





"We made the number 30. We can represent this number as 2 x 15, or 15 x 2. 15 x 2 is the same as counting by two 15 times. We wrote that addition sentence right below. We also know that this could be 30 divided by 15. That means we split the array into 15 groups of 2. But wait, it could also mean that we split the array into groups of 15, and there are two groups."

Pose purposeful questions

In a grade 4 class, students were engaging in a task from *Context for Learning – How big? How tall?* The unit came from the *Groceries, Stamps and Measuring Strips* book in the Investigating Multiplication and Division kit. The students were determining the size of other objects in the picture relative to the height of Antonio. Antonio could be seen in the picture and he was 4 feet tall. Many students used a tool to

indicate the height of Antonio, and then created a measuring tool to measure the other objects. Students quickly realized that Antonio was the same height as the red relational rod. Students made measuring tools by linking red rods together. As students were measuring various items, students were prompted by a teacher:

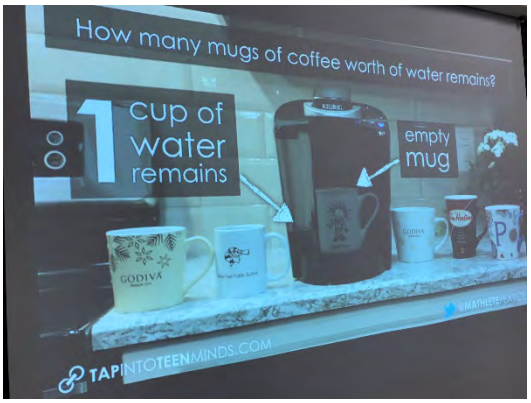
T: "How tall is that building?"
S: "The building is ten Antonio's tall or ten times Antonio, which is 40 feet."
T: "How many buses tall is that building?"
S: "It's 5 times as tall as the bus."
T: "How do you know?"
S: "Because the bus is twice as tall as Antonio, so you need half as many to reach the top of the building."

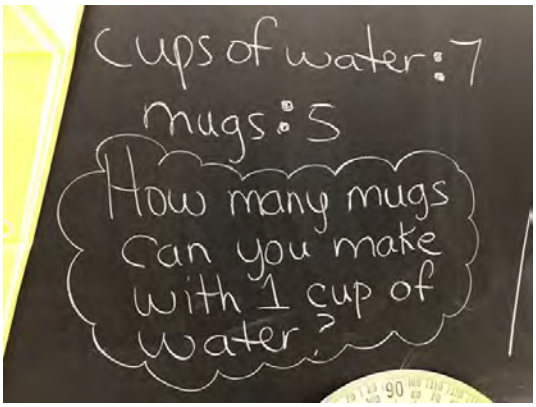
These intentional teacher questions led students to the idea of doubling and halving.

Build procedural fluency from conceptual understanding

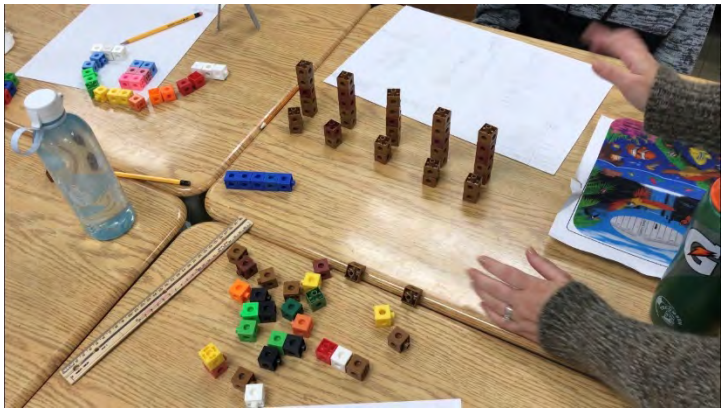
In a grade 7 class, students were investigating the ideas of fraction as quotient and proportional relations.

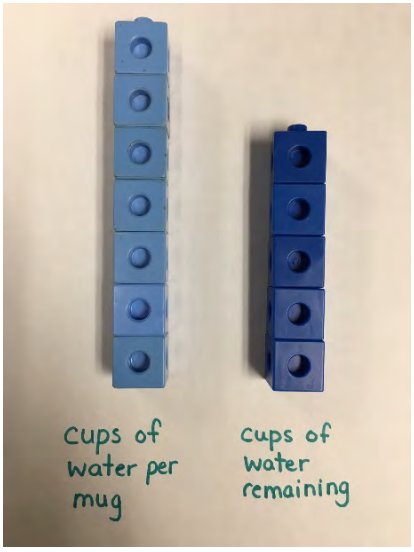
THE TASK:
Students watched a video and observed that a Keurig machine can make five mugs of coffee using seven cups of water, but there was one cup of water left in the reservoir. The students were asked, "How many mugs of coffee can you make with that one cup of water?"





Many students wanted to find out how many cups of water were needed to make one mug of coffee. Most students opted for linking cubes to make sense of this scenario. Many students understood that the seven cups of water needed to be distributed amongst the five mugs (partitive division). Interestingly, some students knew to build their "cups of water" using five linking cubes, while others came to this realization through trial and error. Students were observed sharing out the first five cups easily, but the last two required more consideration. Many students eventually realized that they could distribute the last two cups if they "built the cups of water" using a number of blocks that were divisible by five. Most groups opted for five, while others landed on ten. Once all of the blocks were distributed, the students could clearly communicate that they needed seven fifths cups of water per mug. They could use their models of linking cubes to show why the answer was in fact seven fifths because one whole cup was five fifths, and they used two more fifths.





However, the investigation was not over. Students still needed to find out how many mugs could be made with the one cup of water that was left. Students used their models to determine spatially the comparison between the amounts of water needed to make one mug, and how much water they actually had. They stated that one cup of water was five sevenths of the water that they actually needed.

In this investigation, students used fraction as quotient (partitive division) to reveal the rate that exists between the two quantities that live within this composed unit (ratio of cups of water to mugs of coffee). Students used partitive division to divide 7 cups by 5 mugs and revealed the rate of 7/5 cups of water per mug. Students then used fraction as quotient again (however, this time quotative division) to reveal the multiplicative comparison between the cup of water remaining and the number of cups needed to make one mug. Students revealed that the scale factor between what they had and what they needed was five sevenths. This step also revealed the reciprocal rate (seven fifth (7/5) cups per mug versus five seventh (5/7) mugs per cup).

These procedures will be revealed to students numerically over time, however, approaching this task through reasoning, tools and models, all students were able to access the problem. When the procedures are introduced and named more formally, students will be able to build their procedural fluency based on their conceptual understanding.

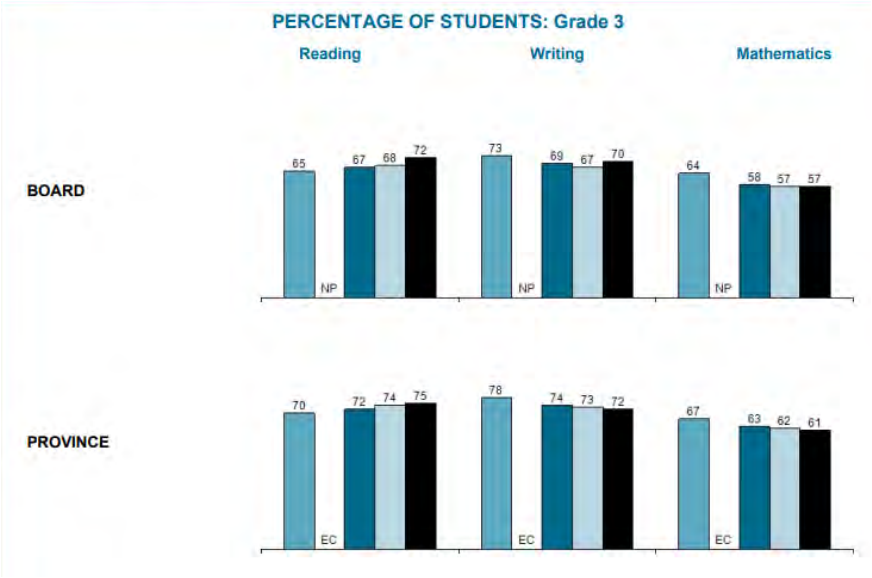
The classroom practice and documented student behavior included in this report highlight five of the eight effective teaching practices. However, ***facilitating meaningful mathematical discourse, supporting productive struggle, and eliciting and using evidence of student thinking*** *are also prevalent in the shared examples*.

EQAO SYSTEM REPORT

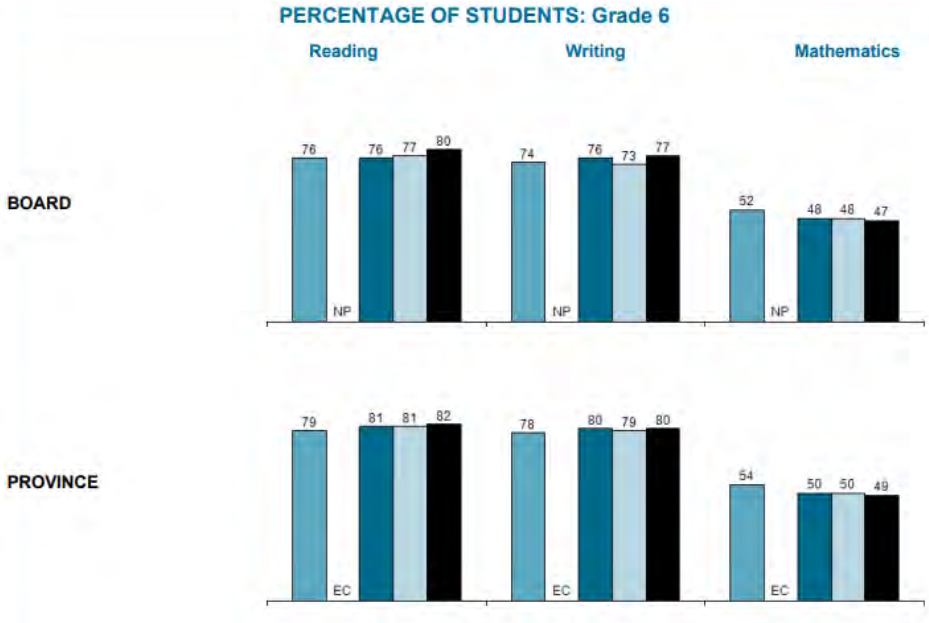
The Education Quality and Accountability Office (EQAO) measures the achievement of students across Ontario in mathematics in grades 3, 6, and 9. The assessments are based on the expectations found in the Ontario Curriculum at the end of each of the respective grades.

The GECDSB mathematics results below indicate the percentage of students in Grade 3, Grade 6, Grade 9 Applied Mathematics, and Grade 9 Academic mathematics who scored at or above the provincial standard. Ontario's provincial standard is equivalent to a "B" grade or 70%.

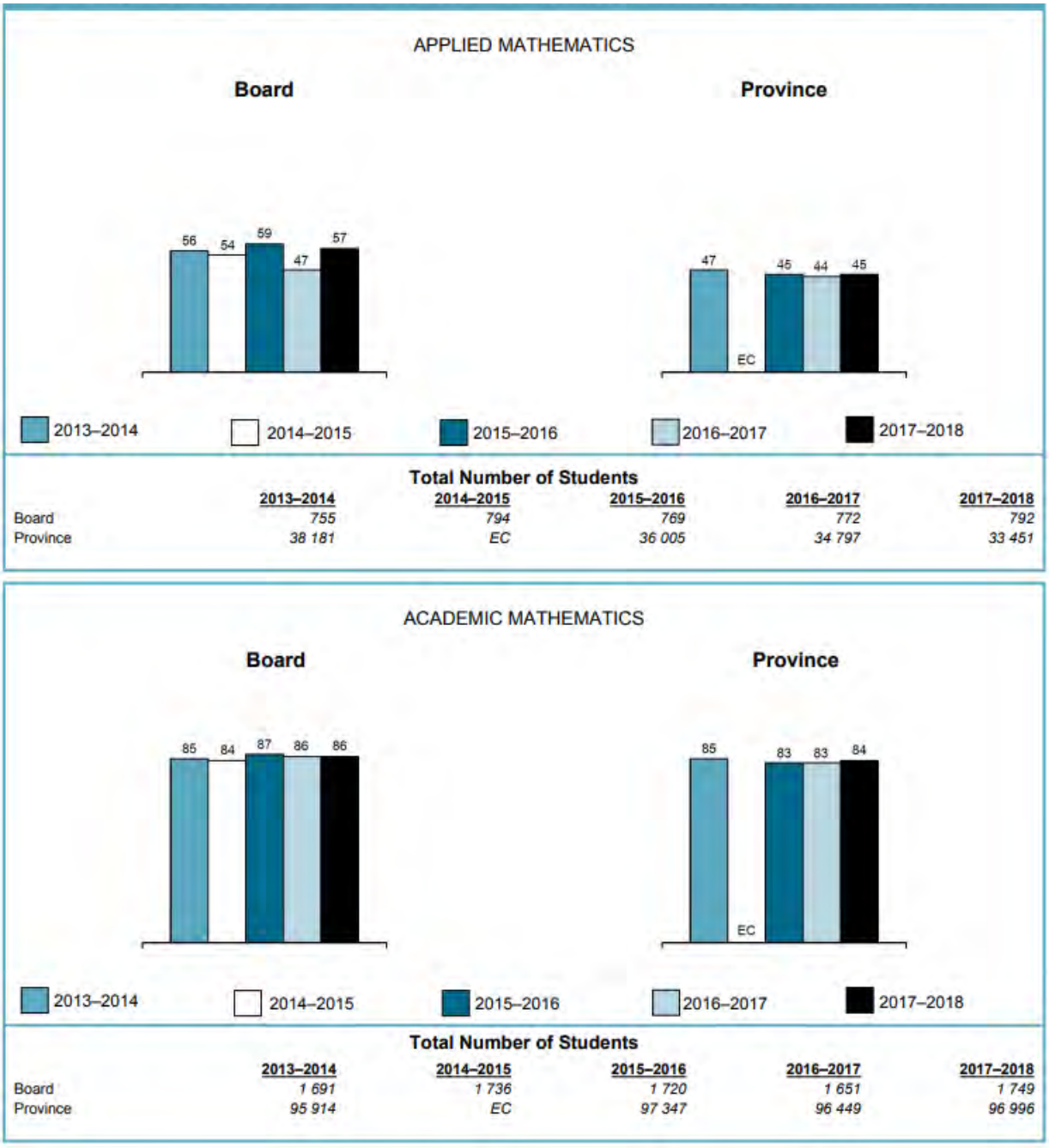
Grade 3 – Three-year trend



Grade 6 – Three-year trend



Grade 9 – Three-year trend



Total Number of Students

	2013–2014	2014–2015	2015–2016	2016–2017	2017–2018
Board	*755*	*794*	*769*	*772*	*792*
Province	*38 181*	*EC*	*36 005*	*34 797*	*33 451*

Total Number of Students

	2013–2014	2014–2015	2015–2016	2016–2017	2017–2018
Board	*1 691*	*1 736*	*1 720*	*1 651*	*1 749*
Province	*95 914*	*EC*	*97 347*	*96 449*	*96 996*

Attitudinal Data Trends

There have been no significant changes in student attitudinal data over the course of the past three years. On average, 55% of grade 3 students indicated that they like mathematics most of the time. 55% of grade 3 students believe that are good at math most of the time. On average, 49% of grade 6 students indicated that they like mathematics, while 53% of grade 6 students believe that they are good at mathematics.

GRADE 3

2017- 2018

STUDENT ENGAGEMENT About mathematics:		
I like mathematics.	11 / 32 / 56	*1 337*
I am good at mathematics.	6 / 38 / 55	*1 305*
I am able to answer difficult mathematics questions.	12 / 50 / 36	*869*
I do my best when I do mathematics activities in class.	18 / 78	*1 868*

2016-2017

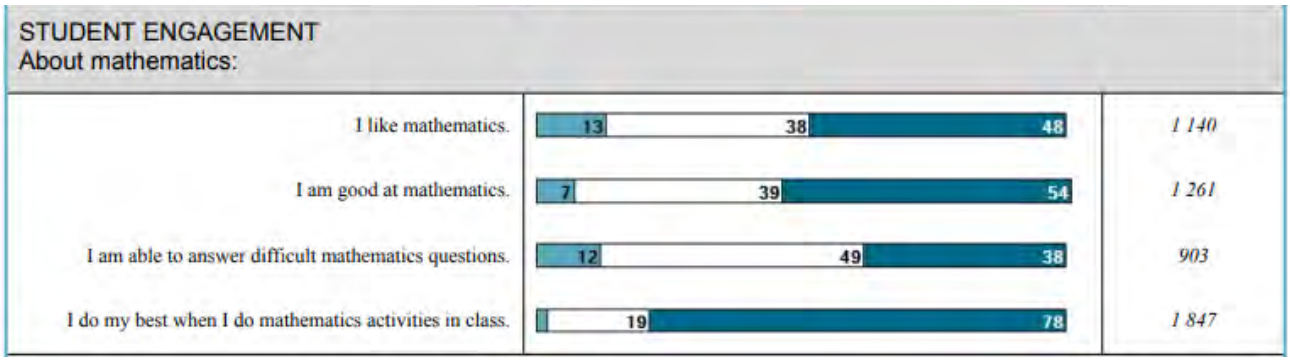
STUDENT ENGAGEMENT About mathematics:	Percentage of Students*	*Number of students who answered "most of the time"*
I like mathematics.	9 / 35 / 53	*1 256*
I am good at mathematics.	4 / 39 / 55	*1 293*
I am able to answer difficult mathematics questions.	10 / 52 / 36	*848*
I do my best when I do mathematics activities in class.	18 / 77	*1 810*

2015-2016

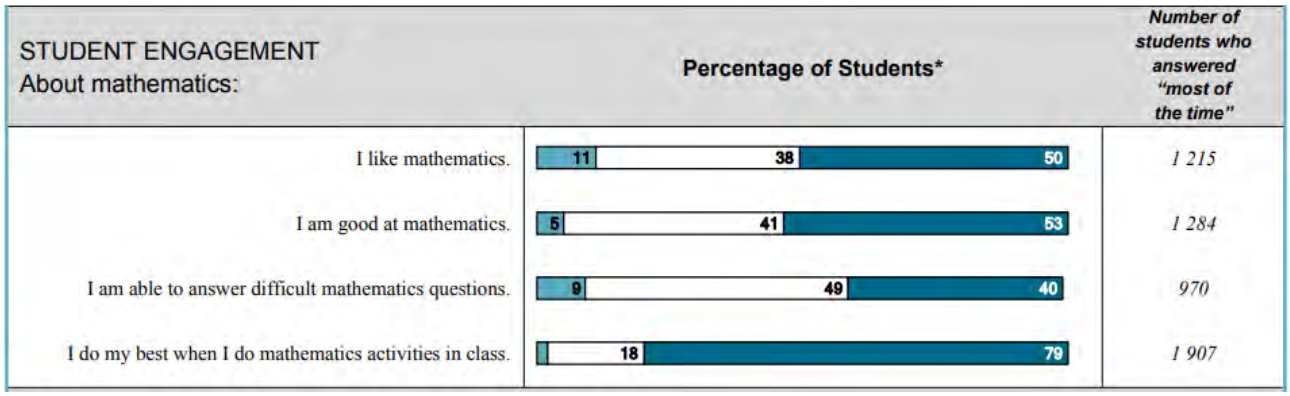
STUDENT ENGAGEMENT About mathematics:		
I like mathematics.	11 / 32 / 56	*1 309*
I am good at mathematics.	6 / 39 / 54	*1 266*
I am able to answer difficult mathematics questions.	11 / 49 / 39	*911*
I do my best when I do mathematics activities in class.	17 / 79	*1 843*

GRADE 6

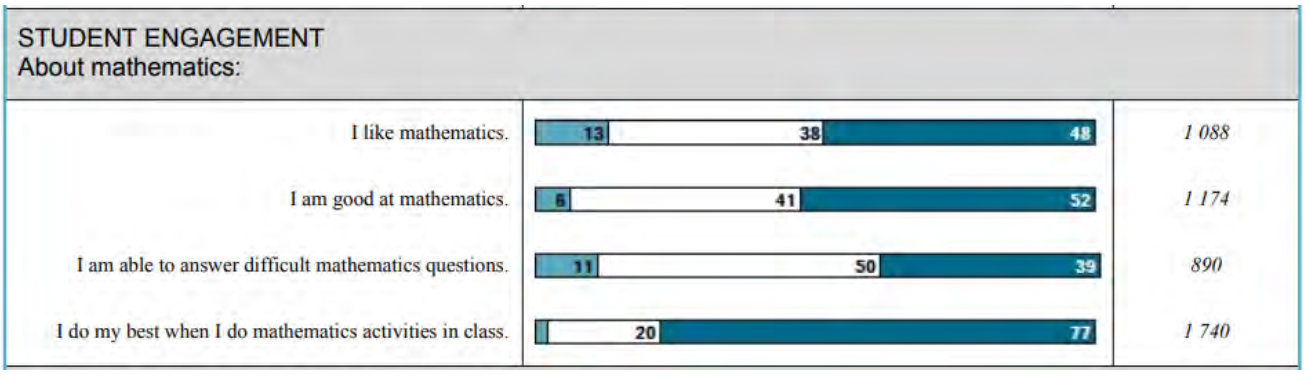
2017-2018



2016-2017



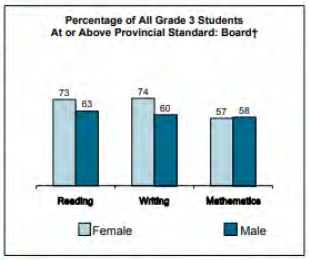
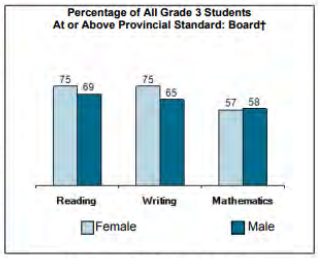
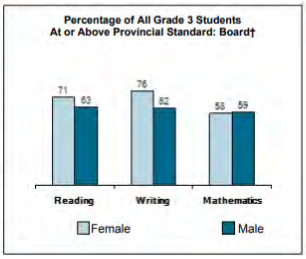
2015-2016



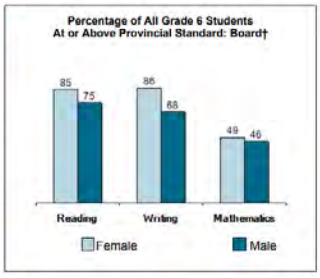
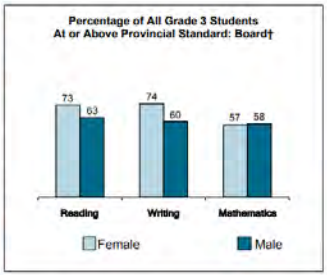
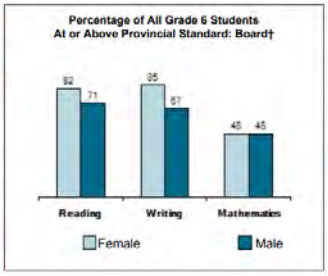
Gender Gap Trends

There has been no significant difference between male and female students in terms of percentage of all grade 3 and 6 students at or above the provincial standard in the past three years. The minimal difference between the performance of male and female students has been maintained for three years. Since the 2012-2013 assessment, the gender gas been reduced by 2-3% in both grade 3 and 6.

GRADE 3

2017-2018	2016-2017	2015-2016
		

GRADE 6

2017-2018	2016-2017	2015-2016
		

Areas of Need

In 2017-2018, the released questions where grade 3 students fared poorly (less than 50% achieved the provincial standard) were question #2 and question #17.

2 Samir has these coins.

He spends $1.75.

How much money does he have left?

- ○ $2.25
- ○ $2.50
- ○ $3.50
- ○ $4.25

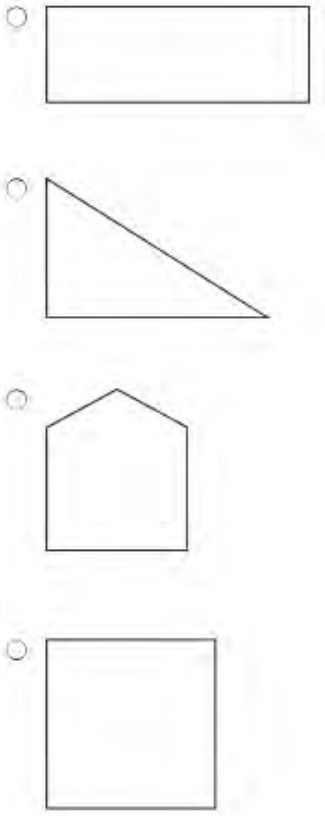
Strand:
Number Sense and Numeration

Overall Expectation: solve problems involving the addition and subtraction of single- and multi- digit whole numbers, using a variety of strategies

Knowledge and Skill:
Application

Board average score: 40%
Province average score: 41%

17 Which shape below has vertical, horizontal and diagonal lines of symmetry?



Strand:
Geometry and Spatial Sense

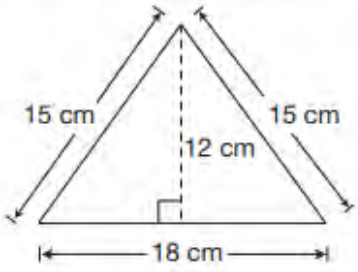
Overall Expectation: identify and describe the locations and movements of shapes and objects

Knowledge and Skill:
Application

Board average score: 41%
Province average score: 46%

In 2017-2018, the questions that challenged grade 6 students (less than 55% achieving the provincial standard) were question #2, question #6, question #8, and question #16.

2 What is the area of this triangle?



- 48 cm^2
- 90 cm^2
- 108 cm^2
- 216 cm^2

Strand:
Measurement

Overall Expectation: determine the relationships among units and measurable attributes, including the area of a parallelogram, the area of a triangle, and the volume of a triangular prism

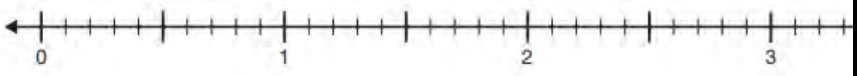
Knowledge and Skill:
Application

Board average score: 53%
Province average score: 52%

8 The values of four points are given.

Point A	$\frac{6}{5}$
Point B	$\frac{7}{10}$
Point C	$2\frac{1}{2}$
Point D	$\frac{12}{4}$

Plot and label these points on the number line.



Draw and label Point E on the number line so that it is between Point C and Point D.

What is the value of Point E?

Strand:
Number Sense and Numeration

Overall Expectation: read, represent, compare and order whole number to 1 000 000, decimal numbers to thousandths, proper and improper fractions, and mixed numbers

Knowledge and Skill:
Application

Board average score: 55%
Province average score: 57%

16 Tyson empties 6 jugs of milk into a container.

Each jug contains 4 L of milk.

He uses the container of milk to fill cartons.
Each carton requires 250 mL of milk.

How many cartons will he be able to fill?

- ○ 16 cartons
- ○ 24 cartons
- ○ 63 cartons
- ○ 96 cartons

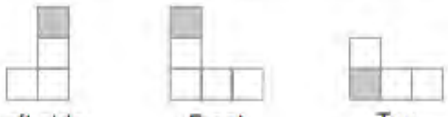
Strand:
Measurement

Overall Expectation: determine the relationships among units and measurable attributes, including the area of a parallelogram, the area of a triangle, and the volume of a triangular prism

Knowledge and Skill:
Thinking

Board average score: 34%
Province average score: 34%

6 These are the left side, front and top views of a 3-D figure made of connecting cubes.



Left side view | Front view | Top view

How many cubes are needed to make this figure?

- ○ 4
- ○ 5
- ○ 6
- ○ 9

Strand:
Geometry and Spatial Sense

Overall Expectation: sketch three-dimensional figures, and construct three-dimensional figures from drawings

Knowledge and Skill:
Thinking

Board average score: 50%
Province average score: 48%

PRIME

Context

Prime assessments have been administered in 27 schools across the system to measure impact on student achievement. The Number, Operations, and Measurement tools have been used based on the school's focus. Approximately 1 450 students have been assessed this year. The initial pre-data has suggested areas of strength and areas of growth.

AREAS OF STRENGTH	AREAS OF GROWTH
Students can: • Represent whole numbers • Compare whole numbers • Count whole numbers (including skip counting by 2s, 5s and 10s) • Identify coins and their value • Rote counting • Operate with whole numbers	Students are working on: • Counting values of coins to $1.00 (Primary) • Comparing and ordering fractions (across all three division) • Comparing and ordering decimals (Junior and Intermediate) • Comparing fractions to benchmarks (across all three divisions) • Operate with fractions (Intermediate) • Using tools for measurement • Determining relationships among units and measurable attributes • Metric Conversions

Math Coaches

Math coaches used PRIME to monitor impact on student achievement in 8 schools. The tools used were "Measurement" and "Operations".

- Based on sample to date: 568 students (5 schools)
- Only students with Pre & Post PRIME data
- 499/568 improved- 88%, an average increase of 5.0 pts
- 57/568 remained status quo- 10%
- 12/568 regressed- 2.0%

AREAS OF STRENGTH	AREAS OF GROWTH
Students can: • Identify coins & their value (Primary) • Unitize- the smaller the unit the more there are • Demonstrate an understanding of linear measurement concepts • Perform rote computations • Skip count • Operate with whole numbers especially adding and multiplication	Students are working on: • Understanding that the unit is the space between • Metric conversions • Vocabulary • Personal benchmarks • Reasonableness of estimation • Using tools for measurement • Strategic competence using algorithms (standard & alternative/invented algorithms) • Mental math– especially inverse operations • Operate with decimals (place value) and fractions (Junior/Intermediate)

GATHERING VOICE: Data Report

Math Educator Survey 2018

Context

During the September 21, 2018 Professional Development day, Educators in all elementary schools were asked to complete a survey to identify levels of teacher efficacy, belief and pedagogical content knowledge in the area of mathematics.

A similar survey was conducted in February, 2016.

Response Rate

In 2018, 1437 educators responded to the survey. This is an increase from the 912 responses received in 2016.

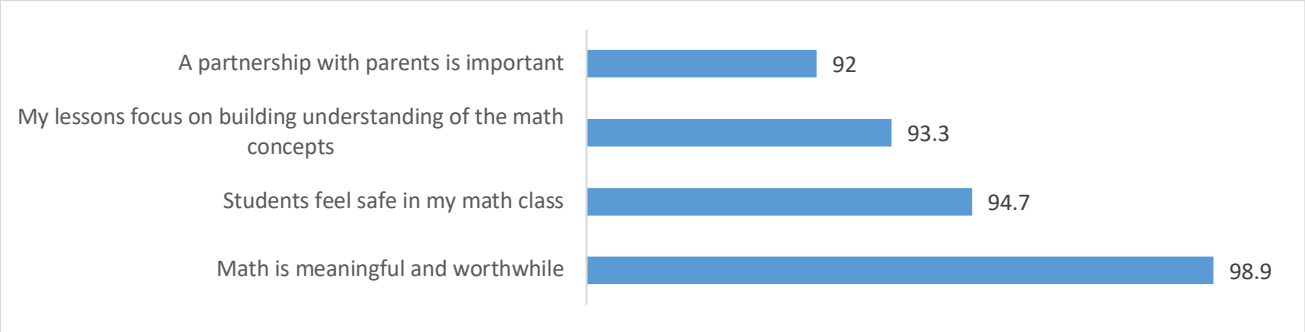
Survey Results

STATEMENT	2016	2018
1. I like math	84%	86%
2. I like teaching math	88%	86%
3. I am good at math	72%	72%
4. Math is about reasoning through a problem	89%	89%
5. Math is about understanding the big idea/concept	87%	90%
6. Math is useful and worthwhile	99%	99%
7. I consistently communicate with parents about math	34%	43%
8. I feel that a partnership with parents is important	91%	93%
9. I feel my students are prepared to learn math	75%	70%
10. I regularly consolidate math	79%	79%
11. I consistently use assessment for learning in math	86%	88%
12. I consistently use flexible groupings of students	79%	84%
13. I regularly prompt for metacognition	72%	73%
14. I consistently use a three part math lesson	50%	57%
15. I frequently use a variety of math resources	90%	92%
16. I consistently facilitate math talk in the classroom	79%	88%
17. I usually use technology for math learning	52%	54%
18. I consistently use manipulatives in my lessons	83%	88%
19. My math instruction results in success for students of all abilities	70%	76%
20. My lessons focus on building understanding of math concepts	95%	93%
21. I feel that my students are successful in learning math	84%	80%
22. I have a strong understanding of math concepts that I teach	90%	86%
23. I have a strong understanding of math procedures	81%	80%

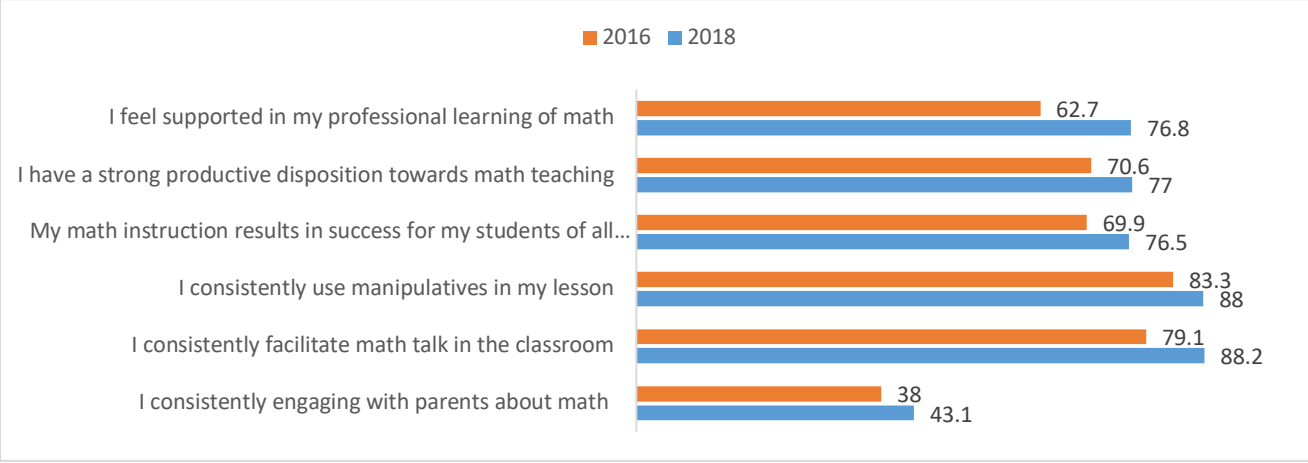
24. I have a strong productive disposition towards math teaching	70%	77%
25. I have a strong understanding of ways to formulate, represent and solve math problems	74%	76%
26. I feel supported in my professional learning of math	62%	77%
27. I have the resources that I need to teach math	60%	64%

Summary of Survey Data

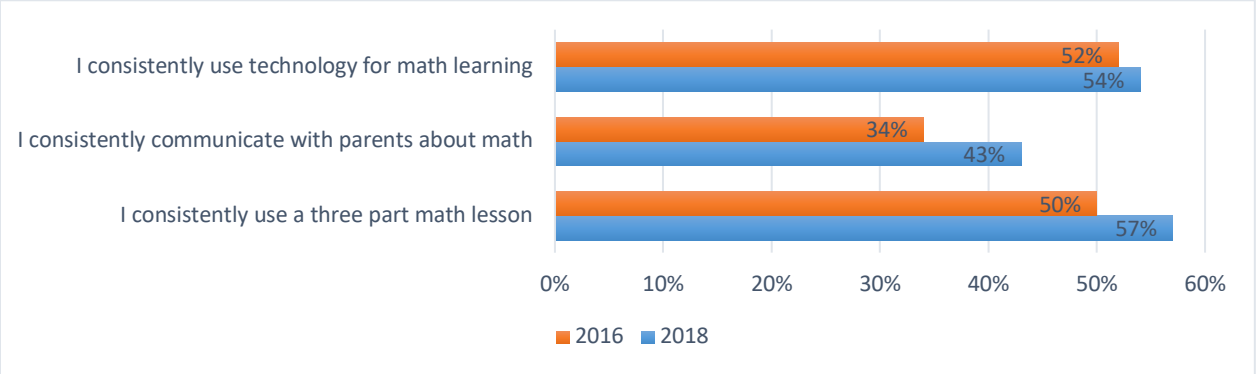
Based on the results of the survey conducted in 2018, an overwhelming 98.9% of educators feel that math is meaningful and worthwhile. 94.7% of educators have indicated that their students feel safe in their math classroom. 93.3% indicate that their lessons focus on building understanding of the math concepts, and 92% feel that a partnership with parents/guardians is important.



Since the survey was conducted in 2016, the number of educators consistently engaging with parents/guardians about math increased by 5.1%. The consistent facilitation of math talk in the classroom increased by 9.1%. The consistent use of manipulatives in educators' lessons increased by 4.6%. Educators' perception that their math instruction results in success for their students of all abilities increased by 6.5%. The surveyed educators' productive disposition of math teaching increased by 6.4%. The number of educators who feel supported in their professional learning of math increased by 14%.



In the 2018 survey, 56.6% of educators are using the three-part math lesson structure, which is an increase of 7.1% since 2016. 43% consistently engage with parents/guardians about math. 53.9% of educators surveyed consistently use technology for math learning.



Math Administrator Survey 2019

Context

A total of 91 administrators completed the survey. The respondents included Principals and Vice Principals in the GECDSB elementary and secondary panels. The majority of respondents indicated that they had over 10 years of teaching experience. The respondents also indicated that the majority had over 6 years administrative experience. A similar survey was conducted in 2016.

Of the total respondents, 14% indicated that they had additional qualifications in mathematics (an increase of 4% since 2016) and 6% indicated that they had a mathematics teachable qualification (a decrease of 4% from 2016). The decrease in the number of administrators with a math teachable is as result of retirements.

The perceptual data measured in the survey examined varying aspects of evidence of parent engagement, effective teacher practice, and leadership capacity in mathematics. The following analysis is based on the total number of administrator responses.

Survey Results

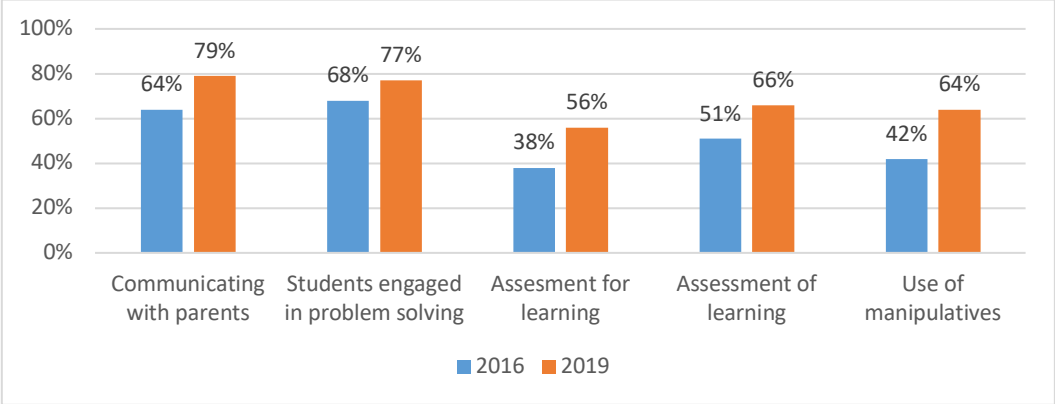
Based on response of “agree” or “strongly agree”

STATEMENT	2016	2019
1. I observe teachers consistently communicating with parents.	64%	79%
2. I create opportunities for parents to support their child(ren)’s learning in the classroom.	71%	65%
3. I consistently notice students engaged in problem solving.	68%	77%
4. I consistently notice students engaged in consolidation of math learning.	43%	47%
5. I notice consistent assessment for learning in math.	38%	56%
6. I notice consistent use of assessment of learning in math.	51%	66%
7. I consistently see students using manipulatives.	42%	64%

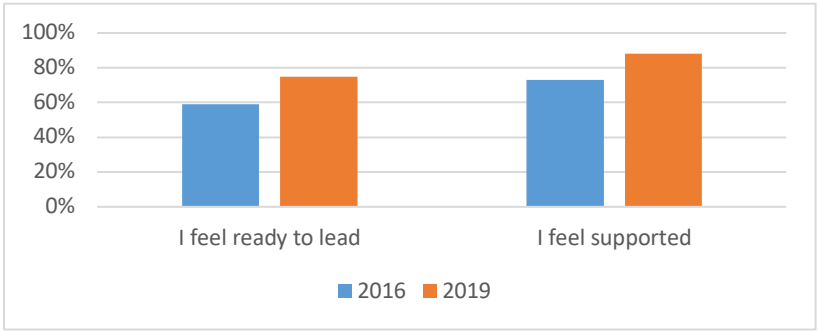
8. I notice most/all students engaged in math talk in the classroom.	76%	71%
9. I feel ready to lead math teaching and learning in my school.	59%	75%
10. I feel supported in leading math learning.	73%	88%
11. I would like professional development in math content.	73%	88%
12. I would like professional development in math pedagogy.	78%	85%

Summary of Survey Data

Since the survey was conducted in 2016, the number of principals who consistently see educators communicating with parents/guardians has increased by 15%. Principals who consistently noticed students engaged in problem solving increased by 9%. The consistent use of assessment *for* learning in math has increased by 18%. The consistent use of assessment *of* learning in math increased by 15%. Principals who consistently see students using manipulatives increased by 22%.



The number of principals who feel ready to lead math learning in their school increased by 16%. There was an increase of 15% in the number of principals who feel supported in leading mathematics.



88% of principals indicated that they would like continued professional development in the area of math content. 85% indicated that they would like professional development in the area of math pedagogy.

The number of principals who indicated that they create opportunities for parents/guardians to support their children in mathematics decreased by 6%. The number of principals who noticed most or all students engaged in math talk decreased by 5%. The number of principals who consistently observe students engaged in the consolidation of mathematics was a change of 4% from 43% to 47%.

Parent/Guardian Survey 2019

Context

A total of 345 parents/guardians completed the survey. Representation was demonstrated by nearly all GECDSB schools, with children in grade JK through grade 12.

Survey Section

The first set of questions measured parents'/guardians' perception of the level of home/school communication, their level of efficacy to support their child's learning at home, and their use of online supports.

Results based on response of "agree" or "strongly agree"

STATEMENT	2016	2019
1. I feel I receive consistent communication from my child(ren)'s school/teacher about math.	34%	35%
2. I feel I have opportunities to support my child(ren)'s learning in the classroom.	51%	42%
3. I feel well-prepared to help my child with math at home.	69%	55%
4. I actively encourage a positive attitude towards education.	98%	97%
5. I closely monitor my child(ren)'s progress at school.	90%	92%
6. I contact my child(ren)'s teacher for math support.	20%	34%
7. I make use of online GECDSB homework help (Mathify).	9%	9%
8. I use online supports provided by the school/teacher.	21%	25%
9. My child(ren) and I use other online math supports.	33%	39%

Open-Response 1: "Please list the various online math supports that you and/or your child uses."

There were 137 responses in this section. Parents/guardians identified an array of online math supports which encompassed two main categories: videos and demonstrations; and problems and practice. Parents/guardians were able to identify specific apps, sites and software including YouTube, Mathies, Desmos, IXL and Kahn Academy. Of the 137 respondents, 24 parents/guardians mentioned that their children are using either Zorbits of Knowledgehook. A few parents/guardians made mention that no online tools had been shared with them. The French Ministry licensed online math support "Netmaths" for students in grades 3 through 5 French immersion was not mentioned.

Open-Response 2: "List the various ways in which you communicate with your child(ren)'s school/teacher about math."

There were 162 responses in this section. The responses in this section were extremely varied. Some parents/guardians mentioned only communicating with teachers during parent-teacher interviews and report cards, or not at all. Other parents mentioned receiving student work samples including tests and assignments as well as notes in the agenda. A few parents/guardians identified reaching teachers by phone or in person, however sometimes finding it difficult to connect. There were a few mentions of

monthly or weekly newsletters. There were 35 responses that indicated Edsby as form of communication; however the response regarding Edsby was varied. Some parents/guardians noted regular and effective communication via Edsby, while others mentioned little to no communication via Edsby, or that they find the app difficult to navigate. There were also a few mentions of other apps such as Twitter, Seesaw and Remind.

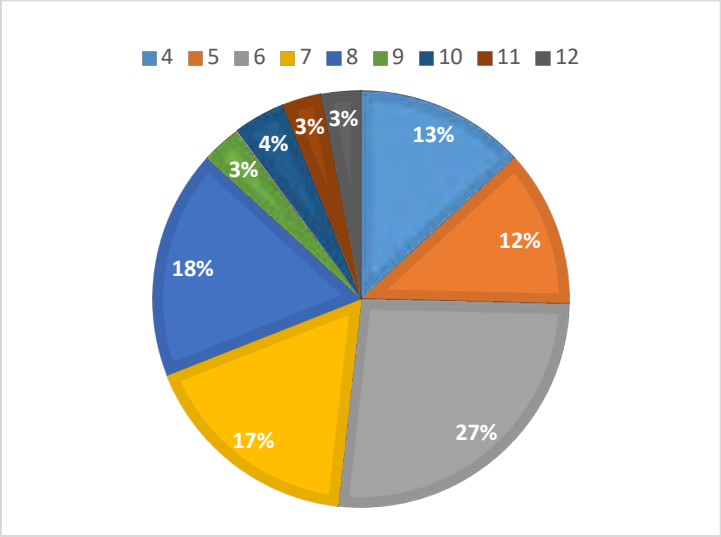
Open-Response 3: General Comments

There were 122 responses in this section. The general comments reflected a few themes. A group of parents/guardians who feel that their children are engaged and supported in mathematics and who feel ready to support their child at home. They appreciate the interactive games that their children are doing to support the development of number fluency and are excited about their child's interest in learning math. Many parents/guardians communicated that they feel unable to support their children at home because they do not understand or support the "new math" being taught. A number of parents/guardians communicate through open response that they would prefer if students were taught the way that they experienced math in school.

Student Survey 2019

Context

3169 students completed the survey. The proportion of students in elementary school was significantly higher than those in secondary (see Graph : Current Grade).



Of the total respondents, 48% were male and 50% were female.

The perceptual data measured in the survey collected student attitudes, use of technology and manipulatives, classroom experience and beliefs regarding mathematics.

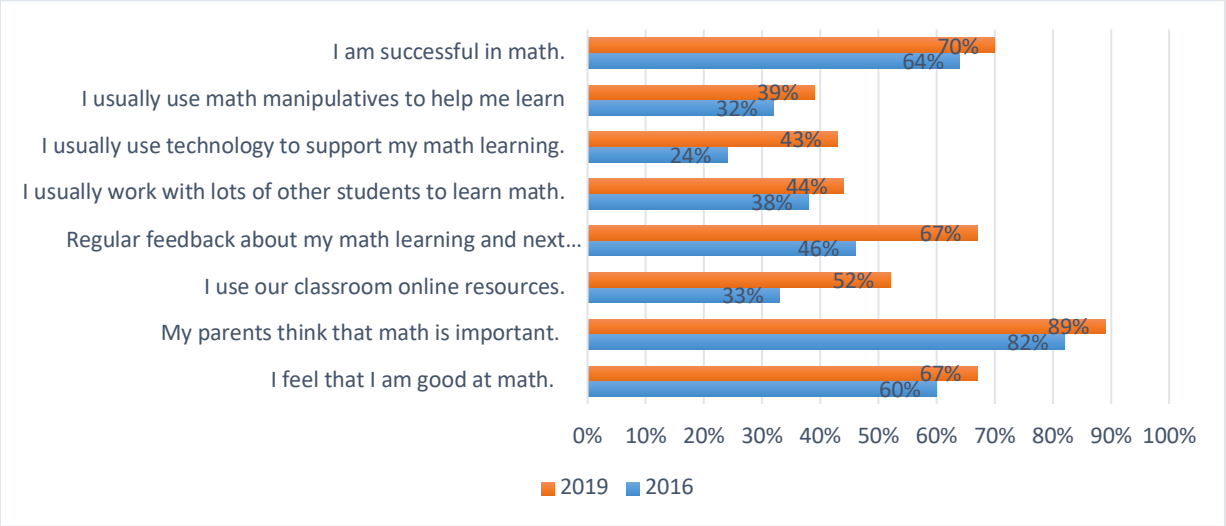
Survey Section

STATEMENT	2016	2019
I like math.	59%	63%
I feel that I am good at math.	60%	67%
My parents/guardians think that math is important.	82%	89%
I use Mathify as an online homework support.	14%	9%
I use our classroom online resources.	33%	52%
I usually learn math by solving problems	69%	72%

I learn by discussing the different ways that other students solved the problem.***	74%	55%
I can solve math problems many different ways.***	66%	68%
Regular feedback about my math learning and next steps help me as a learner of mathematics.***	46%	67%
I usually work with lots of other students to learn math.	38%	44%
I talk about my math learning in my classroom.	51%	52%
I usually use technology to support my math learning.	24%	43%
I usually use math manipulatives to help me learn.	32%	39%
I am successful in math.	64%	70%
I usually use a variety of tools or models (drawing, manipulatives, number line, array...) to understand the math.	N/A	54%
I usually use a variety of tools or models (drawing, manipulatives, number line, array...) to communicate my thinking	N/A	52%

*** Wording of the statements was altered slightly from the original survey.

Since the survey was conducted in 2016, the number of students that feel that they are good at math has increased by 7%. Students' perception that their parents/guardians believe math is important has increased by 7%. Student who indicate using available classroom online resources increased by 19%. The number of students who indicate that regular feedback supports their learning has increased by 21%. Students who indicated regularly working with other students to learn math increased by 6%. The number of students who report using technology to support their learning increased by 19%. The use of manipulatives to help students learn increased by 7%. Students who feel successful in math increased by 6%.



A number of students who indicated that they learn by hearing the solutions of their peers decreased by 19%. This change might be attributed to how the wording of the question was altered from the 2016 to the 2019 version of the survey.

The difference between the elementary student responses and the secondary student responses were analyzed. There were no significant differences to report.

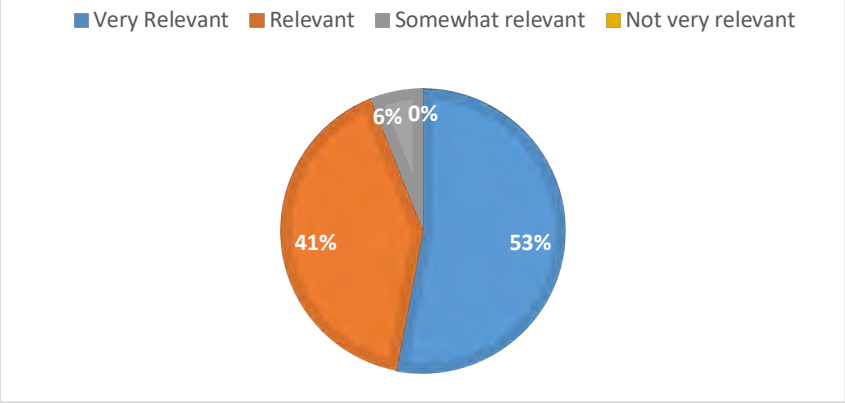
System Supported Mathematics Learning 2016-2018

Professional Development Opportunity	Number of Educators Directly Impacted
Administrator Capacity Training – Principals & Vice Principals (2016-2017)	100
Administrator Capacity Training – Principals (2017-2018)	55
Math Leads (2016-2017)	225
Kindergarten Professional Learning Day (September 2017)	355
Workshops, Not A Book Talks & Moderating Mathematics – Math Leads (2017-2018)	225
System PD – Proportional Reasoning, Fractions & Measurement - Grade 1, 4, 7, Math Lead and LST (2018-2019)	175
Mathematics Learning Leadership Project (MLLP) – 12 participating schools	70
Summer Institutes (Summer 2018)	150
OAME Annual Conference (May 2018)	20
OAME Leadership Conference (November 2018)	50
Learning Beyond the Horizon Summer Conference (August 2018)	180
Kindergarten PD (December 2018)	54
K-1 Critical Transitions Team (2017-2018)	10
K-3 Action Group (December 2018)	16
RISE PD – Context for Learning (November 2018)	75
Focusing on the Fundamentals of Math (September 2018)	All Elementary Teachers
Summer Learning “Camp Wonder” (2018)	79
Math Coaches (September 2018- December 2018)	70+

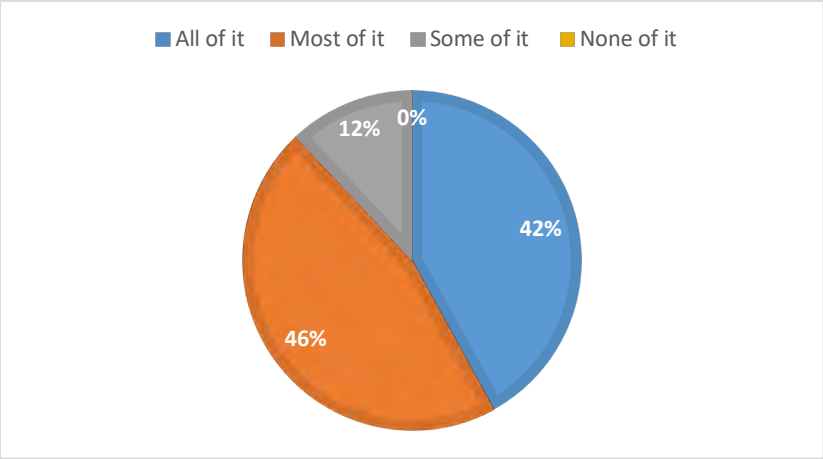
Educator Feedback from System Supported Mathematics Learning

The following results are based on exit tickets collected from educators who participated in System PD, RISE PD, and Kindergarten PD from September 2018 to December 2018.

I felt that the learning today was relevant to my needs.



I will be able to use the information that I learned today in my classroom.



The most significant takeaways from the learning sessions as identified by participating educators

"Planning will be done with IEP goals more in mind because I can focus on one great resource. Assessment can be more authentic because it's in the moment and feedback can be given and the kids can quickly adjust to their learning."

"All students can solve problems if we permit different entry points and allow for rich discussion and inquiry."

"Know students entry point and differentiate from there."

"All the great math we did that can easily be done in class tomorrow!"

"I think that in the 5 proficiencies, the adaptive reasoning and procedural fluency are important to really solidify in Kindergarten when we are exploring and making mistakes. We are able to help the students explain their thinking and be comfortable doing it. These are such important skills (as are the others) that the kids carry with them throughout and often struggle with."

"Assisted us as teachers/ lead learners to understand exactly where students are at, and what is our precise targeted teacher move to support students to the next step in the continuum of math learning (or landscape) and support our teachers back at our school with this journey."

"I feel all of it was significant. I enjoyed learning more about the math proficiencies and principles as well as how to use Zorbits with my students and families. Other resources were also shared which I believe will be helpful in supporting student learning. And best of all...we can use it in French Immersion!"

"A greater understanding of unitizing and how proportional reasoning emerges in primary grades. My attention is now more focused on "multiplicative thinking."

"Analyzing student work and debating what we see (moderating) is key to developing my own understanding of what students can do and determining next steps."

“Have conversations with students in order to understand their thinking.”

“How to use student learning in order to plan for the next step.”

“The lesson format: a simple task, extend the task asking for models representing your answer, choose the model you want them to learn about, give a challenge to apply the model, consolidate by choosing interesting solutions that extend thinking and make connections.”

“All the strands are intertwined. How to pull learners at different levels into the same learning activity.”

“Thinking more of measurement as also fractions, spatial reasoning, ratio, etc... also a good reminder to think of measurement and fractions not only in a linear manner. Also, being sure to predict what students might do so to better plan the teaching to lead to my learning goal.”

“The difference between ratio and rate reasoning. The importance of teacher questions to illicit understanding/guide next steps.”

Summer Learning

In 2018, the GECDSB Summer Learning Program provided rich summer learning opportunities for 784 children across a variety of programs and camps. In 2018, there were 29 combined literacy and numeracy sites. These sites were facilitated by 79 educators. GECDSB educators received 2 days of professional development focused on counting and quantity.

At Camp Wonder, every classroom must include:

- A Variety of Numeracy Activities
- A Focus on Developing a Growth Mindset
- Opportunities for Student Inquiry
- Daily Number Talks
- Daily Small-Group Instruction

Mathematics Assessments (Measuring Impact on Student Achievement)

- 70% of the students in the sample demonstrated improvement in counting;
- 75% of the students demonstrated improvement in addition;
- 90% of the students demonstrated improvement in subtraction.

Percentage of Students Scoring 80% or higher on Leaps and Bounds Assessment

Counting		Addition		Subtraction	
Pre	Post	Pre	Post	Pre	Post
50%	80%	65%	78%	20%	48%

The research conducted through Summer Learning helps to identify the effect of innovations before they are taken to scale. The impact of *Leaps and Bounds* for the purpose of assessment and providing targeted intervention through small group instruction, and its related impact on student achievement, was a factor in the consideration of purchasing this resource for the system.

Impact of Summer Learning on GECDSB Educators

On the 2018 educator surveyed, teachers were asked to identify whether or not they had been an educator with the GECDSB SLP. The impact of this experience and the related professional development opportunities was analyzed using the system results as a base line.

AREA	SLP	System
Consistently Engage with Parents	53%	43%
Usually Use Technology	70%	54%
Three Part Lesson Structure	72%	57%
Access to Resources	74%	64%
Prompt for Metacognition	79%	73%

Confident Teaching Mental Math	80%	74%
Understand GECDSB Vision	82%	77%
Strong Productive Disposition towards math	85%	77%
Provide Opportunities for Inquiry	88%	84%
Consistent Parent Communication	89%	83%
Constant Use of Assessment of Learning	91%	85%
Foster Student Creativity	93%	84%
Consistently Flexible Groupings	94%	84%
Partnership with Parents	98%	92%
Consistently Use Manipulatives	98%	87%

Participating in the Summer Learning Program (SLP) in the role of educator reflected an increase in teacher efficacy. The most noteworthy difference was indicated in aspects of mathematics teaching and learning that are considered core components of the program. Some of those aspects include: use of manipulatives, inquiry based learning, parent partnerships and productive disposition towards mathematics.

Student Success

Number of educators our work has helped	EDHS Herman KCI LDSS RSS Walkerville Western WVFA	***13*** teachers of grade 9 applied math have presented about / spoken to the impact our work has had on their instructional and assessment practices, including: • Assessing by learning goals • Formative assessment via Knowledgehook • Small group instruction • Spiraling • Using manipulatives This impact extends beyond these teachers and into mathematics departments at their schools (***35+***).
	5 RMS secondary schools: Kennedy, Kingsville, Riverside, Western, Westview	At these 5 schools, we have supported ***9*** teachers through our work.
	Families of schools	Via pineapple chart style PD sessions, grade 7 – 10 teachers of applied level math (***150+)*** within every family of schools met for observation, co-planning, and discussion.
Number of teachers who have requested support	Over 3 years	2-3 teachers x 14 schools = ***28 – 42*** each year

Grade 9 applied EQAO scores	2017 – 2018 school year	At the 5 schools with which we are aligned, the grade 9 applied EQAO scores have improved an average of 14%, with top 3 improvements of 17%, 21%, and 25%.

The impact of *Student Success* can be measured in the improvement in grade 9 applied EQAO scores. At the 5 schools with which *Student Success* is aligned, the grade 9 applied EQAO scores have improved an average of 14%, with top 3 improvements of 17%, 21%, and 25%.

Staff Turnover

Administrative Changes – Elementary

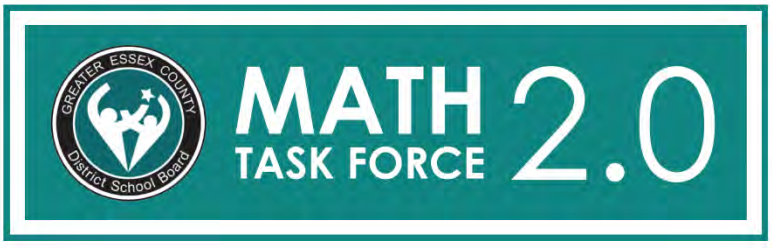
- New Since 2015-2016
  - Principals – 13
  - Vice-Principals – 15

Eligible for Retirement in 3-5 Years (Projected)

- Elementary Principal – 14
- Elementary Vice-Principal – 5

Educator Changes – Elementary

	June 2016	June 2017	June 2018	Next 3-5 (Projected)
Retired	30-35	30-35	30-35	150
Hired	30	54	75	---------



The promotion of the use of various types of data collected at multiple points in time is critical to determining strengths and next steps. Such triangulation of findings may help provide a more balanced approach to decision making, reduce the reliance on any single data source, and determine actionable behaviour.

CONSIDERATIONS

Consideration	Actions Taken to Date	Suggested Future Actions or Suggested Next Steps
1. *Continue with a district–wide, K-12, multi-year model for professional learning focused on deepening and increasing educator content knowledge, pedagogical knowledge, and pedagogical-content knowledge. The professional development model should focus on deepening the understanding of the five proficiencies, various tools, models, representations and the consolidation of learning. The goal of this model should be to improve math learning for every student in every classroom.*	• **Administrator Capacity Training (ACT) Sessions (Year 1 and 2)** • **Math Liaise Training Year 1 and 2** • **12 Math Leadership and Learning Program (MLLP) schools and 43 in System learning PD (Year 3)** • **Year 3 focus on Gr. 1,4,7** • **Summer Math Workshops, OAME Conference, Kindergarten PD, Summer Learning PD** • **Differentiated Learning for Educators (Book Talks, Workshops, Moderation of Math Tasks** • **School Based Learning Days**	• Continue with system PD, Phase 1 – Grade 1, 4, 7, Phase 2- Grade 2, 5, 8, Phase 3- Grade 3, 6, 9 • Continue with face to face, virtual professional development and system learning and MLLP structures for school learning • Focus of the learning must include various tools, models and representations as well as a focus on the five proficiencies and the consolidation of learning. • Develop an online professional learning models accessible to all staff
2. *Continue with a formal leadership program to build capacity for school based administrators in pedagogical, content knowledge and pedagogical content knowledge. A focus on leadership actions to support mathematics teaching and learning is key. A learning plan for new administrators needs to be considered.*	• **ACT Sessions in Year 1 and 2** • **System Principal Meeting PD** • **Administrator Learning Teams** • **Math Leadership Learning Project (MLLP)** • ***Principles to Actions* book for all administrators**	• ACT sessions (4-6 sessions) • Create a differentiated learning model for new administrators due to the expected high number of new administrators over the next 3 years. • Learning sessions include how to facilitate learning • Ignite Leadership learning specifically in the area of mathematics • Develop a framework of mathematics learning in a school – what are the big ideas that educators and administrators need to know and understand to support math teaching and learning • Demonstrate how to create a scope and sequence of mathematics
3. *Consider a critical focus on the implementation of effective research based teaching practices that promote mathematical proficiency.* *(NEW)*		• Take the work form Principles to Actions and the work of Gene Hall and Shirley Hord to support the implementation of change • Leverage the pre-existing work of the Principles to Actions Administrator Team • Leverage the existing Administrator Learning Team (ALT) model • Connect implementation focus to BIPSA and SIPSA goals • Connect to considerations 1 and 2
4. *Revise the GECDSB Math Vision to include direct connections to the 21st Century competencies. The 21st Century competencies are to be reflected in the details of the comprehensive professional learning plan and monitoring plan (Consideration 1 and 11).*	• **Addendum to the Math Vision created, posted, and shared** • **Math Vision was included in all work in Consideration 1 and 2**	• Make direct connections to 21st Century competencies in professional learning sessions • Create a research brief on 21st Century competencies

5. *Continue to include Student Led Learning Walks and Student Centred Learning Communities as part of the District Review Process. Consider the implementation of a process whereby student voice is gathered and considered to support math learning in every school*	• **Incorporation of greater student voice in the District Review – Student Centred Learning Community (SCLC) Process** • **Addition of Student-Led Learning Walks (SLLW) to District Review** • **Addition of a student panel discussion to District Review which promotes teacher reflection on the responsive learning environment**	• Include the Student Led Learning Walks research brief in the Math Task Force 2.0 report • Schools collect student voice twice per year (minimum) focused on math learning (develop a protocol to support this process)
6. *Design professional development to focus on cross curricular connections and learning Focus on STEAM designed learning. (NEW)*		• Integration of Science, Mathematics, Engineering, Technology and Art (STEAM) • Design specific PD to demonstrate STEAM designed learning (explicit to build understanding and implementation of high quality STEAM learning activities) • Leverage robotics resources and coding across the system • Infusion of more resources and kits to support STEAM designed learning • Emphasize explicit connections to curriculum expectations when using STEAM designed learning
7. *Educator learning should continue to be supported through the provision of mathematics instructional coaches in both panels focused on the work in Considerations 1, 2, and 11. Math coaches should be aligned to schools based on student learning needs.*	• **New elementary coaching model includes :** • **Data Monitoring- Pre/Post Prime, Pre/Post Surveys, SLLW** • **Aligned Learning Focus with Math Team** • **Teachers released by coaches to create time for professional learning** • **In class time for modelling of effective instruction with gradual release of responsibility** • **Use of open tasks to identify needs and develop targeted interventions** • **Moderation of tasks to develop a continuum of learning** • **See consideration 7 for details of the coaching focus in the secondary panel)**	• Continue with Math Model in both panels and reinforce learning with educators who are engaged in system learning. • Implement a process/protocol for accountability
8. *Consider allocating additional blocks of math instructional time to teachers who have fully engaged in capacity building around the teaching and learning of mathematics (NEW)*		• Administrators should consider timetabling additional blocks of math instruction outside of the homeroom • Develop a strategy to build capacity in all teachers over time • Each year the number of teachers allotted math instruction time will increase as we build capacity

		• New teachers will attend math training each year to support the growth of teacher capacity (connect to consideration 1) • Learning around effective teaching of mathematics should continue for all teachers
9. *Continue specific supports provided for teachers in grade 7-9 focused on co-constructing understanding of effective instructional practices, assessment practices, and supporting transitions and course sections.*	• **AEAC workshops for teachers in grades 7-9, both grade specific and cross-panel, focused on instructional and assessment practices such as: manipulatives, spiraling, small group instruction, EQAO data tool, assessing by learning goals** • **Family of Schools sessions for grades 7, 8, 9/10 applied math teachers to observe, discuss and co-plan** • **On-going math coaching at 5 RMS secondary schools in grade 9 applied math classes (Kennedy, Kingsville, Riverside, Western, and Westview)** • **Creation of Intermediate Guidance positions** • **Shadow days for grade 8 students**	• Continue to extend supports for 7-9 learning for educators • Continue to reinforce the five math proficiencies, consolidation, the use of manipulatives, assessing for learning and spiraling
10. *Continue to align homeroom and Special Education RISE classroom and ESL classroom schedules to ensure consistency of math instruction and to allow for extended blocks of time for math instruction. Students returning from the RISE Room or ESL classroom must continue to receive high-quality math instruction with appropriate accommodations and modifications in place.*	• **Professional learning to support the use of Math Games in RISE classrooms to increase student engagement and number fluency** • **Professional Learning with Special Education Coordinators focusing on the Math Vision** • **Professional learning for RISE educators to support student learning needs using Contexts for Learning**	• Provide guidance on what a 60 minute minimum math class looks likes in a RISE room and ESL room
11. *Implement PRIME system wide for early identification of students with math learning struggles. Use Leaps and Bounds to support educators in personalizing specific and timely interventions that support student learning.*	• **Sample use of Leaps and Bounds and PRIME to assess learning needs and inform instruction** • **Summer Learning Program inclusion of resources** • **Professional learning for EarlyON facilitators, Kindergarten and Grade 1 educators (e.g., September PD Day, System PD, after school sessions)** • **Partnership with Math Knowledge Network focused**	• PRIME to be purchased for the elementary panel • Leaps and Bounds to be purchased for the elementary panel • Knowledgehook and Zorbits- support through PD sessions – consider expanding use and support • Continue to work with Knowledgehook and Zorbits in pulling data • Implement a mock Grade 3 and Grade 6 EQAO sample test for moderation and to guide teaching • Provide PD to leverage small group instruction

	on supporting critical transition in mathematics • **Curiosity Club after school program**	
12. *Engage in culturally responsive training for staff to provide support for student populations with historic gaps in achievement. Learning should include developing an understanding of and a response to other learning barriers such as socio-economic status.*	**English Language Learners supports to date:** • **Through collaboration with the Special Education Department, creation of Growing Vocabulary and Math, Kindergarten and Grades 1-3.** • **Creation of Categories of Graphic Organizers booklet** • **Professional Learning Sessions with ESL/ELD Coaches and ESL/ELD teachers on effective strategies of ELLs.** **FNMI Supports to date:** • **FNMI Support Workers- Open Minds Program** • **Making Connections Tutoring Program** • **FNMI Itinerant teacher in- class support** • **Indigenous Focused Collaborative Inquiry- Learning Math Through Beading** • **Open Minds Newsletter- parent communication**	• Explore training available to support culturally responsive teaching • Develop a training plan- possible infusion to already existing training • Explore resources such as We Can't Teach What We Don't Know book • Expand Curiosity Club (if funding is available)
13. *The model for monitoring system impact to leverage the system response to teaching and learning mathematics. The data collection and monitoring should be transparent and shared with all stakeholders and be used to drive system direction and practices in order to support teaching and learning. The Math Task Force should be a voice to support the monitoring.*	• **Educator Efficacy Survey (Pre and Post)** • **PRIME assessment to monitor impact on student achievement (Pre and Post)** • **Evaluating the impact of professional development through educator feedback surveys** • **Anticipation Guides during PD sessions** • **Administrator monitoring template – MLLP** • **School monitoring template – System Schools**	• With the support of critical partners-, review the monitoring plan and process. • Frontload the monitoring process at the commencement of the school year. • Make the process and findings transparent
14. *All departments continue to explore existing practices, supports, and department structures, in order to determine whether they are most effective in providing comprehensive and differentiated professional*	• **Collaboration whenever appropriate between departments to develop coherence as to the focus of the learning in order to best support educator capacity to improve student learning**	• Annual early fall and early spring meeting to discuss plans, messages, resources and monitoring processes.

learning as outlines in Consideration 1.		

15. *Continue to develop resources that support families in promoting and facilitating math learning at home and should be connected to appropriate grade level expectations.*	• **Created Parent Guides to support learning about:**
	  ○ **The Math Vision**
	  ○ **Counting and Quantity**
	  ○ **Subitizing**
	• **Introduced Knowledgehook, Zorbits Math Adventure, and Mathify.com web supports**
	• **Supported intermediate students with learning to navigate Ministry resources including Homework Help**
		• Develop a plan for the next three years that includes desired parent supports, communications along with a budget to support resource development.
		• Allow for translation of resources.
		• Work with GECPIC to support parent engagement for mathematics learning
		• Resources need to be available on the board website
		• Short videos entitled- Kitchen Table Math- real parents and students- model how to change kitchen table math

16. *Develop a working committee with community stakeholders to leverage mathematics teaching and learning and to mobilize knowledge both locally and globally. This committee and partnerships should develop and promote models of reciprocity that support teaching and learning.*	**Partnerships continue to be developed and fostered in a variety of ways including:** • **Locally with Parents through GECPIC, EarlyON Centres, City of Windsor** • **Provincially through universities and other boards e.g., U of W, KNAER (Knowledge Network for Applied Education Research)/MKN (Math Knowledge Network), OAME,** • **Globally through the Reciprocal Learning Program, National Council of Teachers of Mathematics, NORCAN project**	• Strike a committee of community partners inclusive of the University of Windsor, St. Clair College, University of Michigan, Michigan State University, LDAO, W5…. to identify effective teaching practices and structures and to share information among partners. • Leverage research and data collection • Explore ways we can better partner with the Faculty of Education in supporting math teaching and learning for teacher candidates
17. *Develop a plan to review all teacher resources to support mathematics teaching and learning and develop additional teacher resources. (NEW)*		• Review math kits • Development of IC maps for mathematics • Scope and sequence for math • Proficiency posters for all classrooms • Math vocabulary for educators- glossary • Resources specific to support ELL's or Special Education • AQ course support • Framework teaching and learning mathematics • Pedagogical system posters

Please note that all possible action steps are contingent on availability of funding.

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Appendix A: A Vision for Mathematics

The GECDSB provides mathematics education that engages and empowers students through collaboration, communication, inquiry, critical thinking and problem-solving, to support each student's learning and nurture a positive attitude towards mathematics.

Whenever we strive to improve in any way, a vision of what that improvement might be is essential. We need to know what we are working towards and why that is important. We also need to know how we plan to reach that vision.

This vision has been developed specifically by and for the Greater Essex County District School Board through consultations with a wide variety of stakeholders including elementary and secondary teachers and administrators, Curriculum and Program staff, Student Success, and Special Education. The intent of this vision, and the related strategies and approaches to mathematics teaching and learning, is to support schools and educators as they reflect on the needs of their students and how they will address them as part of their ongoing School Improvement Plans.

Within this vision there are various responsibilities we assume. As a school board, we believe our responsibilities are to create conditions for mathematics learning:

- where knowledgeable educators integrate instruction and assessment;
- where educators and administrators are committed to ongoing learning about mathematics and mathematics instruction;
- where learning environments nurture positive attitudes towards mathematics; and,
- where all students have opportunities and support to learn significant mathematics with depth and understanding.

It is the belief of the board that where this vision is actively pursued, and where these responsibilities are met, student achievement in mathematics will increase.

This document will outline some of the strategies, approaches, theories, supports and resources that should be used to meet this vision and these responsibilities.

A Picture of Mathematical Literacy

What is "Mathematical Literacy"?

Conceptual Understanding is the ability to understand mathematical concepts, operations, and relationships.
Procedural Fluency is the skill in carrying out procedures flexibly, accurately, and efficiently, and knowing when the procedures should be applied.
Adaptive Reasoning is the capacity for logical thought, reflection, explanation, and justification.
Strategic Competence is the ability to formulate, represent and solve mathematical problems using an effective strategy.
Productive Disposition is the inclination to see mathematics as useful and valuable.

In order to begin any conversation around improving mathematics we need to share a common understanding of mathematical literacy.

> ***Conceptual understanding*** *is knowledge about the relationships or foundational ideas of a topic.* ***Procedural understanding*** *is knowledge of the rules and procedures used in carrying out mathematical processes and also the symbolism used to represent mathematics. (Van der Walle , Karp, Bay-Williams, 2010)*

An example of this is in the task 55 x 24. The *conceptual understanding* of this problem includes the idea that the problem could be represented as repeated addition, and that the problem could be represented in terms of the area of a quadrilateral, the number of seats in a theatre, and any other scenario they can conceive. The p*rocedural knowledge* could include the ability to carry out the standard algorithm (multiply 55 by 24). The ability to go beyond this algorithm or to create an algorithm (for example, 50 x 20, plus 5 x 20, plus 50 x 4, plus 5 x 4) requires *conceptual understanding* of place value and multiplication.

The Ontario Curriculum refers to ***adaptive reasoning*** when:

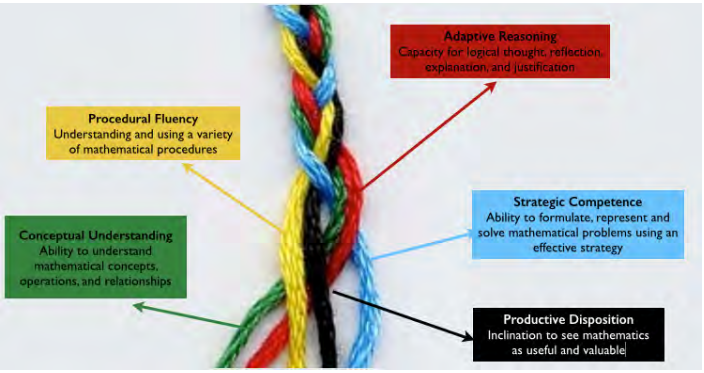
> teachers help students revisit conjectures that they have found to be true in one context to see if they are always true. For example, when teaching students in the junior grades about decimals, teachers may guide students to revisit the conjecture that multiplication always makes things bigger. (The Ontario Curriculum Grades 1-8, Mathematics, 2005, p.14)

It is tempting for teachers to define terms or provide explanations for formulas at the point where students are making conjectures. "Gallery walks and math congresses are opportunities to treat children as developing mathematicians, which emphasizes developing arguments and proofs to convince others" (Models of Intervention in Mathematics).

In approaching a problem, if you feel like you could apply a known or new strategy to solve the problem, try different approaches when the one you selected does not work, and/or create a model to represent your mathematics. This is evidence of ***strategic competence****.*

Mathematically literate people believe they can be successful and are persistent in their approach to problem solving. It is vital that teachers, students, and parents/guardians all strive to develop a ***productive disposition*** towards mathematics.

The following image is adapted from *Adding it Up* (National Research Council, 2001) and is used to show that the each of the elements of mathematical literacy are interwoven to reach the goal of being mathematically literate.



While conceptual and procedural understanding of any concept are essential, they are not sufficient. Being mathematically proficient encompasses all five elements of mathematical literacy. While we may place more emphasis on one element than another at any given moment in time, it is the relationships and links between them that underpin mathematical proficiency.

Nine Considerations When Planning for Mathematical Instruction

1. Program Scope and Planning

Educators consider curriculum expectations, strands, mathematical processes, and big ideas when planning and using curriculum-appropriate resources.

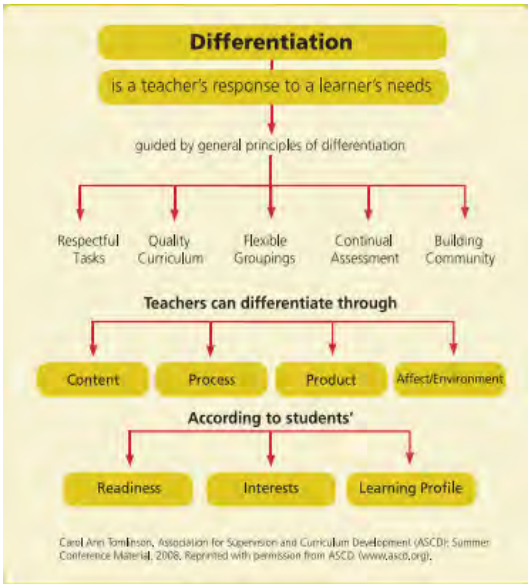
'By organizing content around big ideas, teachers can teach more efficiently, but most importantly, students can make connections between seemingly disparate topics that help them learn new mathematical ideas.' Marian Small from Making Math Meaningful to Canadian Students, K-8 2013

"Life-long learners of mathematics build new knowledge and skills in prior knowledge using the mathematical processes" (MathGains). For more information about the math processes please go to the following website and select 'Introduction and Overview' http://edugains.ca/newsite/math2/mathematicalprocessesvideo.html

2. Teaching and Learning

Educators focus instruction on providing students opportunities to engage in minds-on tasks, mathematical inquiry, and consolidation of their developing understanding of the big ideas.
Educators consider content, process, product, readiness, interests, the student learning profile, and IEP expectations to effectively differentiate instruction to reach all students. Teachers can empower students to feel that mathematics is something he or she can learn through the use of a variety of lesson styles and by differentiating instruction.

Students vary dramatically in their interests, abilities, learning styles and prior knowledge. Differentiated Instruction based on student learning profiles allows teachers to respond, through planning, to the needs of the current math learners within their classrooms. Using different assessment strategies, teachers determine where each student is on a landscape of learning or developmental continuum. By also identifying key math concepts and their connections to curriculum expectations, teachers can then meet the mathematical needs of students while varying other aspect of the lessons and tasks students are required to do (based on student interest and/or readiness).



Inquiry based learning in Mathematics creates a balance between learning based on procedure and learning through problem solving and actively engages all students. This teaching strategy naturally lends itself to differentiated instruction and differentiated assessment and when all students have an entry point the outcome is increased student success. Teachers' careful selection of content rich tasks, Minds On activities that active prior knowledge and make students current thinking visible, and the effective use of consolidation, will deepen students understanding of the curriculum and ensure that all students regardless of their ability, move forward.

3. Learning Environment

Educators use appropriate physical classroom arrangements and group students to promote collaboration, communication and a positive, safe learning environment.

4. Student Tasks

Educators provide an appropriate balance of mathematical tasks including the practice of skills, application of procedures, integration of math processes, and rich problem solving. Even if students have not mastered basic skills, they have opportunities to engage in rich tasks that give them a context for these skills.

The tasks that students are asked to do help them to become mathematically literate as outlined in section 2. Tasks should address curriculum and IEP expectations and take into account the readiness, interests and learning styles of the students in the class. Tasks should be derived from multiple sources and resources, and should allow students ample opportunities to collaborate to develop new math knowledge, and communicate their understandings and wonderings about mathematics.

5. Constructing Knowledge

Educators recognize that a balanced approach is the foundation of the mathematics program for

all students. Effective questioning activates student's prior knowledge, prompts mathematical thinking, and helps students to construct knowledge. Educators also use a skill-based or conceptual approach when appropriate.

Educators recognize that for students to be mathematically literate, and for them to fully understand the mathematical concepts, they have both conceptual understanding and procedural knowledge, they have the capacity for logical thought, reflection, explanation, and justification (adaptive reasoning), they have the ability to formulate, represent and solve mathematical problems using an effective strategy (strategic competence) and a positive disposition towards mathematics and mathematics learning.

6. Manipulatives and Technology

Educators provide students opportunities to use manipulatives and make use of technology to represent mathematical concepts and procedures, solve problems, and communicate their mathematical thinking and understanding.

Educators understand that manipulatives can support students in developing deeper conceptual understandings but that they must also be able to communicate and understand the math they represent. They also recognize that technology has limited capacity to support actual problem solving, but great scope to support students in communicating their thinking and understanding of mathematics to an audience beyond their classroom. The use of technology can also help students to reflect upon their understandings, learn from the understanding of others (adaptive reasoning), and consider different approaches to solving mathematical problems (strategic competence).

7. Students' Mathematical Communication

Educators provide opportunities for students to use communication as both a way to learn mathematics and a way to articulate ideas. Oral, written and physical communication make mathematical thinking observable.

Mathematical communication is an essential process for learning mathematics because through communication, students reflect upon, clarify and expand their ideas and understanding of the mathematical relationships and mathematical arguments. (Ontario Ministry of Education, 2005)

The Ontario Curriculum (Ontario Ministry of Education, 2005) also emphasizes the significance of communication in mathematics, describing it as a priority of both the elementary school and the secondary school programs. Students communicate to:

- build understanding and consolidate learning;
- ask questions, make conjectures, share ideas, suggest strategies, and explain their reasoning;
- learn to distinguish between effective and less effective strategies.
- communication in the math classroom exists in a number of forms (oral, written, symbolic and physical) as illustrated in the table (Figure 1) on the subsequent page.

The use of mathematical language helps students gain insights into their own thinking and develop and express their mathematical ideas and strategies, precisely and coherently, to themselves and to others.

Through listening, talking and writing about mathematics, students are prompted to organize, re-organize and consolidate their mathematical thinking and understanding, as well as analyze, evaluate and build on the mathematical thinking and strategies of others.

Communication	Oral	Written	Symbolic, Graphical, or Pictorial	Physical
Types	Teacher-student (or small group) Teacher-whole class Peer talk Self-talk	Personal writing; Descriptive writing; Process Writing; Word problems	Invented symbolism; Pictorial representations; Graphs; Dynamic; Numeric; Algebraic	Concrete actions
Opportunities	Connections to prior learning; Shared problem-solving; Explanations; Predictions; Comparison of ideas and approaches to approaches to problem-solving; Manipulatives; Relationships; Justification	Prior to learning students can what they know about a specific topic; During learning, students can write to clarify their thinking; After learning, students can add new learning their prior learning or summarize their learning	Use mathematical symbols to represent ideas and demonstrate understanding; Data displays, e.g., pictographs, line graphs, scatter-plots, etc. Mathematical modeling using technology, e.g., virtual manipulatives, graphing software, etc.	Use of manipulatives to communicate thinking; Describing or explaining a concept through demonstration, e.g., describe or explain the concept of perimeter concretely by walking the around the entire outside edge of the patio

Figure 1

8. Assessment

Educators assess for different purposes using a variety of assessment strategies and tools. Assessment practices are fair, equitable, and transparent.

The fundamental purpose of assessment and reporting is to improve student learning. The first of the Seven Fundamental Principles of *Growing Success; Assessment, Evaluation, and Reporting in Ontario Schools*, (2010) emphasizes the need for teachers to use fair, equitable, and transparent assessment and evaluation practices and procedures to support student learning.
What does fair, equitable and transparent assessment look like in mathematics?

Fair assessment and evaluation in mathematics involves:

- multiple opportunities for students to demonstrate the full range of their learning in a variety of contexts;
- curriculum expectations and learning goals that relate to the interests, learning styles and preferences, needs and experiences of all students
- multiple opportunities for students to demonstrate their learning, receive descriptive feedback, and time to act upon that feedback prior to assessment of learning; and
- varied and parallel instructional experiences, including the use of manipulatives and technologies

Transparent assessment and evaluation in mathematics involves…

- ongoing descriptive feedback to students that is clear, specific, meaningful and timely to support improved learning and achievement; and
- learning goals shared with students to identify the intended student learning; and

- success criteria that describe what successful demonstration of the learning goal(s) looks like.

Equitable assessment and evaluation in mathematics involves…

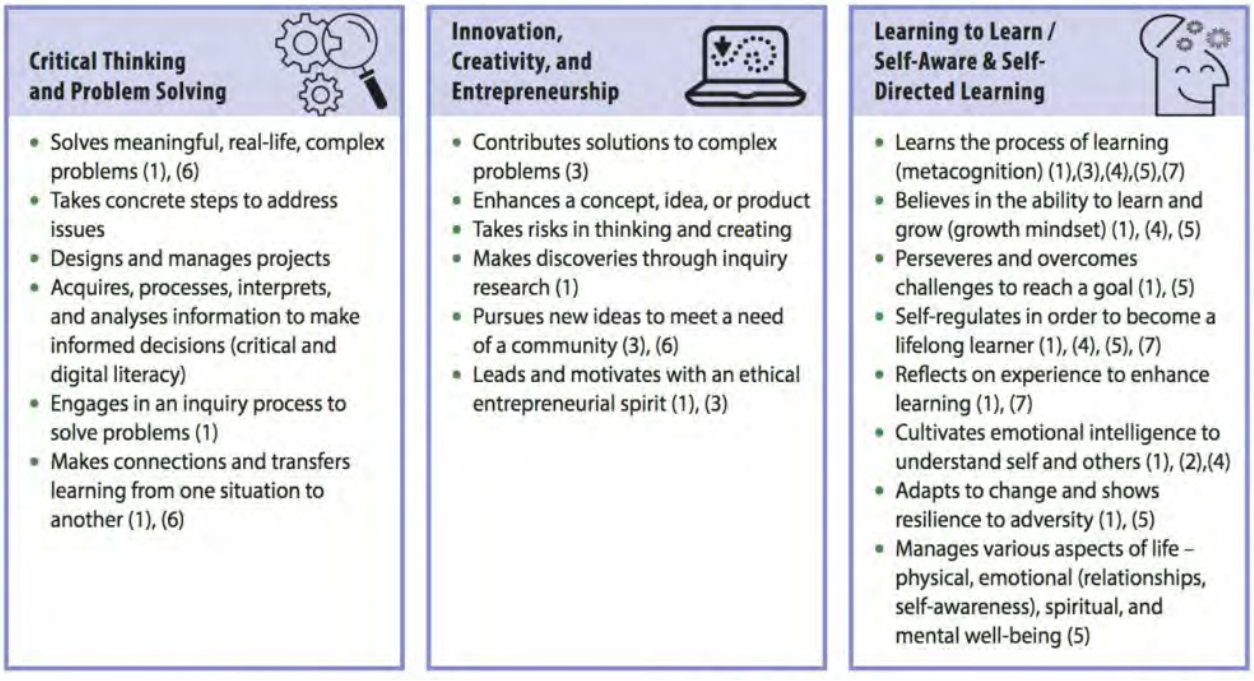
- inclusive support for all students, with attention to those with special education needs, those who are learning the language of instruction (English or French) and those who are First Nation, Métis or Inuit;
- a focus on the same knowledge and skills, while differentiating to meet student needs;
- self-assessment opportunities where students assess their own learning, set specific improvement goals and plan next steps for their learning;
- on-going assessment integrated with instruction to permit teachers to monitor student learning to guide the next steps in teaching and learning.

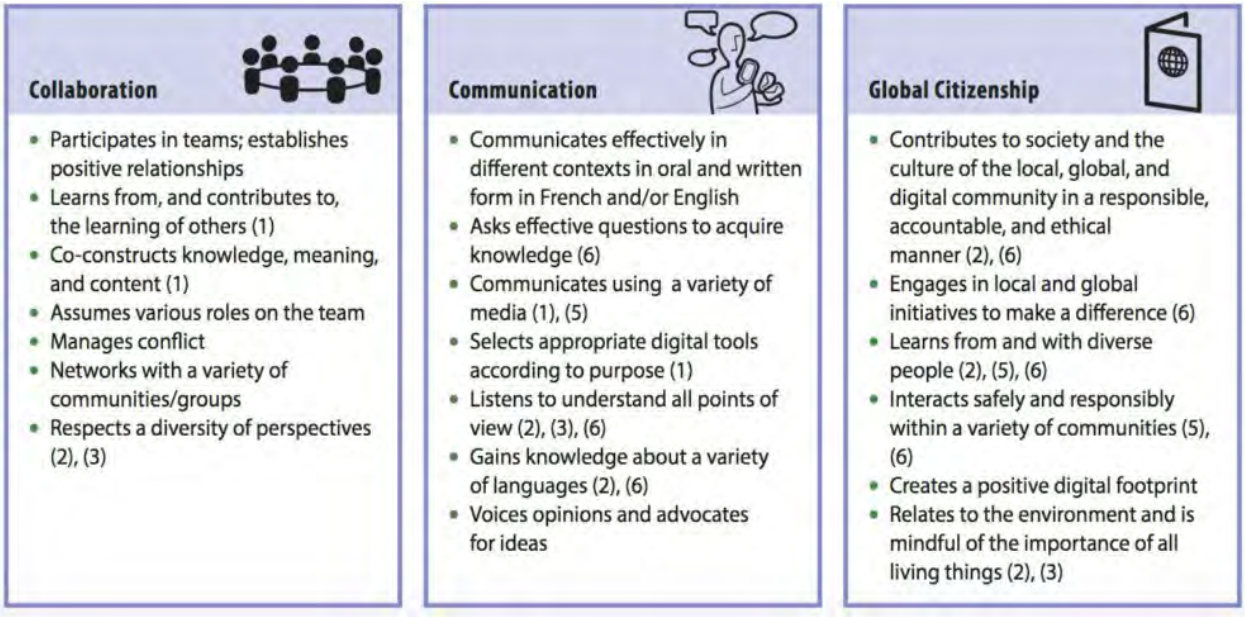
Paying Attention to Mathematics
http://www.edu.gov.on.ca/eng/teachers/studentsuccess/FoundationPrincipals.pdf

Growing Success; Assessment, Evaluation, and Reporting in Ontario Schools (2010)
http://www.edu.gov.on.ca/eng/policyfunding/growsuccess.pdf

9. Global Competencies

GECDSB is dedicated to preparing all students for success. Students must develop the necessary competencies to thrive in an ever-changing world. A current challenge for educators is knowing how to prepare students for their future where they will be asked to navigate a technologically advanced, globally connected and socially conscious world. GECDSB aims to create opportunities for students to develop their 21st century competencies through engaging mathematics classrooms and experiential learning opportunities. The GECDSB Math Vision promotes the learning of mathematics in a way that fosters creativity, communication, collaboration and problem-solving.





(Ontario, 2016)

GECDSB BELIEFS

The responses to the following questions reflect our current understanding about mathematics instruction and learning

What is the Connection between Procedural Fluency and Conceptual Understanding?
Understanding the concepts underpinning mathematics requires individual learners to process information, to make sense of it, and to figure out how to apply it. Memorizing procedures on its own does not develop this understanding. This example from *Making Math Meaningful* by Marian Small illustrates this concept:

"A student who fully understands what 3 x 5 means not only realizes that it equals 15, but, at some point, understands all of the following as well:

- It represents the amount in 3 equal groups of 5, no matter what is in the groups;
- It represents the sum of 5 + 5 + 5;
- It represents the area of a rectangle with dimensions 3 and 5;
- It represents the number of combinations of any 3 of one type of item matched with any 5 of another type of item (e.g. 3 shirts and 5 pairs of pants = 15 outfits);
- It represents the result when a rate of 5 is applied 3 times (e.g. going 5 km/h for 3 hours); and
- It is half of 6 x 5, 5 more than 2 x 5, and 5 less than 4 x 5" (2013)

To engage students in understanding concepts, teachers provide opportunities to learn through problem solving, to use manipulatives as models, and to engage in math talk where students explain ideas and consider the ideas of others.

Introducing formal procedures or algorithms too quickly limits opportunities for students to fully understand math concepts; however, without their introduction at some point in the learning students will not necessarily be able to explore and expand upon the concepts they are considering, nor will they have solid foundations to make judgments over the reasonableness of their answers and efficiency of their methodology. Students who have opportunities to play with invented procedures and consider alternative procedures shared by peers, learning concepts through problem solving will develop the competency to use procedures and algorithms strategically or with procedural fluency, and to judge their own methods against those used traditionally used in mathematics.

Review the previous section on "Mathematical Literacy" to learn more about the relationship between conceptual understanding, procedural knowledge, adaptive reasoning, strategic competence and productive disposition.

What is Math Talk?

A Math-Talk Learning Community is a community where individuals assist one another's learning of mathematics by engaging in meaningful mathematical discourse (Hufferd-Ackles, Fuson and Sherin 2004 p. 82).

Despite the importance of high quality math talk, left on their own, students are not likely to engage in such talk. Teachers play a pivotal role in facilitating these opportunities.

Dr. Catherine D. Bruce, an assistant professor at Trent University in Peterborough, Ontario, and the author of the LNS Monograph Student Interaction in the Math Classroom, identifies five challenges that teachers face when trying to engage students in high quality interactions during math. These are:

- complexities of teaching mathematics in ways they did not experience as students;
- discomfort with their own mathematics knowledge;
- lack of sustained professional development opportunities;
- greater requirement for facilitation skills and attention to classroom dynamics; and
- lack of time, especially in face of curricular demands.

She outlines five strategies for teachers to encourage high-quality interactions, along with evidence for why each is important and how it works:

- The use of rich math tasks;
- Justification of solutions;
- Students questioning one another;
- Use of wait time; and
- Use of guidelines for math-talk.

Whole class discussions can be facilitated using techniques such as Gallery Walk, Math Congress, and Bansho. Although there are many similarities and differences in these strategies (which are

listed in the "Communication in the Math Classroom Monographhttp://www.edu.gov.on.ca/eng/literacynumeracy/inspire/research/CBS_Communication_Mathematics.pdf"), the main purpose for all three is to develop student's communication abilities in math.

Increasing math talk provides students with the opportunity to explain, defend, and justify their mathematical thinking with confidence.

What is the Impact of Teacher Attitudes and Comfort with Mathematics?

"Teachers model and nurture positive attitudes, self-efficacy and engagement in mathematics. As educators gain the mathematical knowledge for teaching, they become more capable –and confident – in helping students extend and formalize their understanding of mathematical concepts. This can contribute to students' development of positive attitudes toward mathematics and an increase in their sense of self-efficacy. Self-efficacy, which is an individual's belief in whether he or she can succeed at a particular activity, plays an integral role in student success. Bruce and Ross discovered that "increases in teacher efficacy led to increases in student efficacy and outcome expectancy and to student achievement" (2010, p. 10). In turn, strong student self-efficacy can contribute to greater enthusiasm and engagement in mathematics" (Ross, 2007, p. 52). *Ministry of Education Ontario, Capacity Building Series #22, Maximizing Student Mathematical Learning in the Early Years, September 2011*

Teacher attitudes towards math matter. The Mathematics Curriculum, Grades 1-8 calls on teachers to bring enthusiasm to the classroom (p.5). It is important to acknowledge that while some teachers are uncomfortable with math, articulating that sentiment with, "I'm not good at math" should carry the same stigma as a claim to being illiterate. It is important for teachers to project a positive attitude about math for students, demonstrating for them that math can be enjoyable and achievable and that developing mathematical literacy is important for living in today's world.

Learning Mathematics for Teaching

In the following video segment, Dr. Deborah Loewenberg-Ball explains that the knowledge that is necessary for math teaching is different from the knowledge necessary for doing mathematics. The good news for teachers who have been uncomfortable with mathematizing themselves is that anticipating student thinking, planning open questions to illicit big ideas, prompting and questioning to support conceptual understanding requires some understanding of math concepts, but more importantly, it requires instructional competency.

Teacher-Efficacy

In this video segment, Dr. Bruce explains how teacher-efficacy is directly connected to student learning and student achievement. She claims that teacher-efficacy is a more reliable predictor of student achievement than socioeconomic status. That is because when teachers believe they are capable of helping students learn mathematics, they persist in supporting students in the classroom, they are not afraid to engage students in rich problems or to take up incorrect responses. "They let learning take place instead of doing a lot of telling." In turn, this teacher-

efficacy translates into student beliefs that they can learn. With this increased student-efficacy, students persist longer with problems. When teachers see students experiencing success with challenging problems, they realize their power to support learning. Teacher-efficacy impacts instructional practice and student-efficacy. Improved instructional practice and improved student-efficacy positively impacts student achievement.

"Remember that how your students feel about mathematics when they begin school in September rests largely on their previous school experiences and the tone at home. But how your students feel about mathematics when they leave your classroom relies on you. It's important for you to convey, through actions and words, that mathematics is essential in today's world. Show enthusiasm for math. Tell your students that you appreciate the usefulness of math. Reinforce for them that you value learning math. Of course if your own experience with learning math was difficult and these comments make you inwardly groan, don't try to fake an attitude of enthusiasm. Skip the commercial, try engaging students in a discussion of math skills that are essential for daily life and let it convey the message about the importance of math"
(Burns & Silbey, 2000, p. 86)

What Could Time for Math Look Like?
As well as having a significant portion of each day dedicated to math instruction and learning, it is imperative that teachers embed mathematics into other subject areas, allowing students to experience the relevance of math, practical and every day applications of math, and the contexts within which math exists in all areas. A comprehensive approach to mathematics would be one where math is evident across the curriculum, time is dedicated for math problem-solving and inquiry, and students are supported in becoming mathematically literate.

Before/minds on	
STUDENT	TEACHER
- Make connections to, and reflect on, prior learning - Share their thinking through discussion in a math talk learning community	-Model a strategy to encourage students to make connections to, and reflect on, prior learning (e.g. Think/Pair/Share, Ticket In, Video Clip, Math Language Recall etc) - Establish expectations and procedures (e.g. roles, groupings, manipulatives, etc) - Activate students' prior knowledge by posing a thought-provoking question/task that sets the stage for learning - Promote a positive classroom environment using math talk learning communities

The three-part math lesson is one effective component of a comprehensive mathematics program and emphasizes student's overall conceptual understanding through problem solving, math talk, questioning, and differentiated instruction. The three-part lesson is an inquiry based model where "students are recognized as the ones who are actively creating their own knowledge" (Marian Small).
The following videos are taken from resources provided by the Literacy and Numeracy Secretariat

to support instruction in mathematics and outline the key concepts and theories underpinning the three-part lesson approach, as well as breaking each part down to show what the possibilities are.

During/action	
STUDENT	TEACHER
- Flexible grouping; pairs, small groups, or independent - Work to make sense of the problem in their own way to deepen and clarify their thinking - Communicate their thinking to one another and teacher through math talk - Use errors as an opportunity for learning - Make their thinking visible - Make connections to other subjects and real-life contexts	-Provide a problem with multiple points of entry - Group students purposefully - Ask probing questions to help focus students' thinking without leading to strategies or solutions - Encourage accountable math talk - Encourage students to represent and explain their thinking - Reconvene the whole group to answer questions or clarify thinking - Observe and assess

After/consolidation	
STUDENT	TEACHER
- Make connections between mathematical ideas and strategies - Apply descriptive feedback based on learning goals and success criteria - Complete a final practice assessment or reflection to demonstrate consolidated learning	Strategically facilitate whole-class and small-group discussions and sharing by: - Asking questions to clarify misunderstandings - Encourage students to explain and understand a variety of solution strategies without evaluation - Summarizing the discussion and emphasizing key points or concepts (i.e. "naming" the math).

What is the Role of the Textbook?

The Ontario Curriculum dictates what should be taught in all mathematics programs. Historically there has been an over-reliance on the textbook at the expense of a focus on curriculum expectations and opportunities to explore math more deeply, not to mention an oversight in the fact that the textbooks and Ontario Curriculum do not completely align.

The emphasis in mathematics instruction needs to be on delivering the content expected in the curriculum in a way that the student can best learn. The textbook does play a role in this process, but is not the driving force behind instruction and is merely a resource to support the teacher in structuring learning opportunities for students. It is not the textbook itself that is a potential problem, but more how it is used and what role it plays in the teaching and learning of mathematics.

There are many factors teachers are asked to consider in their use of the textbook. Firstly, they need to ensure that the textbook content aligns directly to the expectations outlined in the Ontario Curriculum, and from there make a judgment as to the extent to which these expectations are met. Are supplementary activities required? Does the content of the textbook meet the needs of all learners? Will the students be able to present a clear and coherent understanding of the concepts required by the curriculum through the completion of the tasks in the textbook? Is the textbook the most engaging and/or effective way for the students to learn and demonstrate understanding of these concepts? What other resources might be needed?

What other learning opportunities or assessments do the students need?

Once an educator has considered these questions, and acted upon their responses, the textbook will likely have a less prominent role in the math classroom, and other resources and approaches will be in place. The resources will be a useful guide and support for teachers looking to evolve their teaching of mathematics.

What is the Role of the Administrator in Supporting Mathematics?

GECDSB school administrators have a key role to play in improving the mathematics learning in a school. In all areas, not just mathematics, administrators recognize the need to improve as an ongoing process and focus on sustaining those changes that achieve increased student learning, and adjusting the changes that do not. In order to support and promote school improvement, all staff, including administrators, learn current theories and best practices as mathematics education quickly evolves around us. Administrators lead all stakeholders in creating and sustaining a positive mathematics culture across the school.

Schools need a shared focused of mathematics learning for all students that has been collaboratively developed and promotes a high level of expectation from the teacher leading to increased achievement. There are going to be multiple barriers to achieving real sustainable growth. By regularly discussing the school's shared focus, administrators can encourage optimism in the face of everyday problems.

Through the GECDSB School Improvement Planning process, and the nature of "School-Based Learning" our educators have autonomy and ownership over how and what they learn. The improvement goals that drive this shift need to be identified by all stakeholders. Administrators coordinate professional learning opportunities that value teacher's knowledge and experiences and are based on student learning needs. Administrators work collaboratively with their staff to build a long-term plan, to monitor their incremental growth and to adapt their plan in response to new learning.

How Do we Communicate with Parents and Guardians?

Parents and guardians play a vital role in their child's development of mathematics. It is essential that teachers build effective communication between home and school. Teachers are encouraged to articulate with parents and guardians the importance of:

- Building strong, positive attitudes about math;
- Beginning with activities that meet your child's level of mathematical understanding;
- Using their first language to explore mathematics at home if they or their child are more comfortable in that language.

Communication is rarely a discrete, individual act but rather occurs within the context of ongoing exchanges (Adler & Rod- man, 1994). Currently, a number of communication opportunities are

available to teachers, ranging from blogs, school-to-home communication books, to face to face parent conferences. Every communication exchange, regardless of format, should reflect a thoughtful, planned approach and should be viewed as an opportunity for teachers to promote parent/guardian partnerships and, ultimately, to support student learning. Teachers are encouraged to use a variety of strategies, keeping in mind that the more proactive you are the better. The more you explain to parents/guardians up front, the less defensive work you'll have to do. As educators, if we want parents/guardians to be on our team, we must initiate, define, and practice what we want that relationship to look like.

Recent research suggests that creating a partnership climate in schools can improve math proficiency for students (Sheldon, Epstein & Galindo, 2010). Schools and teachers can go beyond communication activities to engage parents/guardians as partners in supporting student math learning. Some challenges to family involvement in math learning include:

1) Math is used differently at home, but teachers haven't been guided to take students' social contexts into account when planning math instruction; and

2) Most teachers have little education about how to involve parents/guardians in supporting children to extend their math skills.

Some ways that GECDSB teachers are currently building math partnerships with families include:

- Math Take Home Bags – Students take home a math bag once a week that has an activity they can engage in with their family, like measuring items around the home, reading a picture book and with prompts for math thinking, or conducting a survey of family members about a topic the class is investigating.
- Electronic Communication
- Math Goal Setting – Students take home a questionnaire to complete with their parents/guardians about the child's goals for mathematics. Parents/guardians suggest possible ways they can support their child with the goal from home. Parents/guardians are then invited in to the classroom later in the year for a demonstration by students about how they are progressing towards their goals using evidence from their work in class and at home.
- Math Nights and Workshops – Schools and teachers are hosting parents/guardians for evening sessions where they engage families together in problem solving, explain about the math program and help parents/guardians to better understand how they can help support their child's math development. Parents/guardians are also given the opportunity to provide input for the school's efforts to improve mathematics.

References

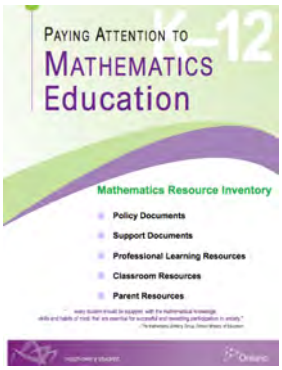
Adler, R. B., & Rodman, G. (1994). Understanding human communication. Orlando, FL: Harcourt Brace College Publishers.

More resources

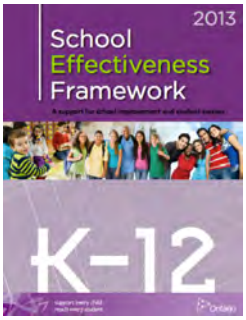
http://www.edu.gov.on.ca/eng/studentsuccess/lms/files

http://www.edu.gov.on.ca/eng/literacynumeracy/parentguidenum2012.pdf

Resources



The Ontario Ministry of Education has developed a comprehensive list of Ministry resources, research, guides and supports for educators in Ontario. Click here to access this great resource.



The School Effectiveness Framework is a tool to guide the work in our schools. Click here to see the Framework, or click here to see which areas may be particularly pertinent to mathematics.

Appendix B: Gathering Voice Data Tools

Grades 4-12 Student **Math Survey**

	SA	S	AS	D	SD
1. I like math.					
2. I am good at math.					
3. My parents think math is important.					
4. I use Mathify as on online homework help tool.					
5. I use our classroom online resources.					
6. I usually learn math by solving problems.					
7. I learn by discussing the different ways that other students solved the problem.					
8. I can solve math problems many different ways.					
9. Regular feedback about my math learning and next steps help me as a learner of mathematics.					
10. I usually work with lots of other students to learn math.					
11. I talk about my math learning in my classroom.					
12. I usually use technology to support my math learning.					
13. I usually use math manipulatives to help me learn.					
14. I am successful in math.					
15. I usually use a variety of tools or models (drawing, manipulatives, number line, array...) to understand the math.					
16. I usually use a variety of tools or models (drawing, manipulatives, number line, array...) to communicate my thinking.					

SA – Strongly Agree A – Agree AS – Agree Somewhat D – Disagree SD – Strongly Disagree

Parent/Guardian **Math Survey**

	SA	S	AS	D	SD
1. I like math.					
2. I feel I receive consistent communication from my child(ren)'s school/teacher about math.					
3. I feel I have opportunities to support my child(ren)'s learning in the classroom.					
4. I feel well-prepared to help my child with math at home.					
5. I actively encourage a positive attitude towards education.					
6. I closely monitor my child(ren)'s progress at school.					
7. I contact my child(ren)'s teacher for math support.					
8. I make use of online GECDSB homework help (Mathify).					
9. I use online supports provided by the school/teacher.					
10. My child(ren) and I use other online math supports.					

SA – Strongly Agree A – Agree AS – Agree Somewhat D – Disagree SD – Strongly Disagree

***Educator* Math Survey**

	SA	A	AS	D	DS
1. I like math					
2. I like teaching math					
3. I am good at math					
4. Math is about reasoning through a problem					
5. Math is about understanding the big idea/concept					
6. Math is useful and worthwhile					
7. I consistently communicate with parents about math					
8. I feel that a partnership with parents is important					
9. I feel my students are prepared to learn math					
10. I regularly consolidate math					
11. I consistently use assessment for learning in math					
12. I consistently use flexible groupings of students					
13. I regularly prompt for metacognition					
14. I frequently use a variety of math resources					
15. I consistently facilitate math talk in the classroom					
16. I usually use technology for math learning					
17. I consistently use manipulatives in my lessons					
18. My math instruction results in success for students of all abilities					
19. My lessons focus on building understanding of math concepts					
20. I feel that my students are successful in learning math					
21. I have a strong understanding of math concepts that I teach					
22. I have a strong understanding of math procedures					
23. I have a strong productive disposition towards math teaching					
24. I have a strong understanding of ways to formulate, represent and solve math problems					
25. I feel supported in my professional learning of math					
26. I have the resources that I need to teach math					

SA – Strongly Agree A – Agree AS – Agree Somewhat D – Disagree SD – Strongly Disagree

***Administrator* Math Survey**

	SA	A	AS	D	DS
1. I observe teachers consistently communicating with parents					
2. I create opportunities for parents to support their child(ren)'s learning in the classroom					
3. I consistently notice students engaged in problem solving.					
4. I consistently notice students engaged in consolidation of math learning.					
5. I notice consistent assessment for learning in math.					
6. I notice consistent use of assessment of learning in math.					
7. I consistently see students using manipulatives.					
8. I notice most/all students engaged in math talk in the classroom.					
9. I feel ready to lead math teaching and learning in my school.					
10. I feel supported in leading math learning.					
11. I would like professional development in math content.					
12. I would like professional development in math pedagogy.					

APPENDIX C: Learning Briefs

GREATER ESSEX COUNTY DISTRICT SCHOOL BOARD

Creating International Conversations

The GECDSB believes in learning together and seeks out opportunities to build conversations with our international partners. The Reciprocal Learning Program is an initiative developed between the University of Windsor, the Greater Essex County District School Board, Southwest University, and Chong Qing schools. This partnership has helped to shift the conversation from: comparison to collaboration; from obstacles to opportunities; and from limits to learning.

The Greater Essex County District School Board provides mathematics education that engages and empowers students through collaboration, communication, inquiry, critical thinking, and problem-solving, to support each student's learning and nurture a positive attitude towards mathematics.

GECDSB, A Vision for Mathematics, 2016

The purpose of these learning briefs is to share the research, discussion and insight garnered from the intensive work of the Greater Essex County District School Board's Math Task Force. These papers are rooted in the GECDSB core beliefs, the Full-Day Early Learning—Kindergarten program and the Ontario Mathematics Curricula for grades 1-8, 9-10, and 11 & 12. The briefs are meant to elevate, enrich and extend the discourse of mathematics education with the intention of encouraging a positive and productive disposition toward mathematics for all learners.

Each paper provides a list of sources to extend the professional conversation and enhance the learning. In addition, live links appear at the end of the papers with connections to various resources.

MATH TASK FORCE

A comparison between nations that examines achievement scores in isolation of the culture and context is incomplete and ultimately inadequate in informing the work of educators.

This partnership has helped to shift the conversation from: comparison to collaboration; from obstacles to opportunities; and from limits to learning.

MATH TASK FORCE

CREATING INTERNATIONAL CONVERSATIONS

Mathematics achievement is a global focus. Sound bites in the media share bits of data from international reports that rank and compare countries. However, when conclusions about student achievement are limited to 140 characters, we miss the fullness, insight and depth of the evidence. A comparison between nations that examines achievement scores in isolation of the culture and context is incomplete and ultimately inadequate in informing the work of educators.

The Reciprocal Learning Program is an initiative developed between the University of Windsor, the Greater Essex County District School Board, Southwest University, and Chong Qing schools, which has become the essential part of a 7-year Canada-China Reciprocal Learning Partnership Project funded by the Social Sciences and Humanities Research Council of Canada (SSHRC) with five other Canadian and Chinese partner institutions (Xu & Connelly, 2013). The goals of the Reciprocal Learning Program are: to provide an exceptional learning experience for teacher candidates, educators and administrators; to expand perspectives regarding societies of increased diversity; to foster international collaboration among faculty members who are interested in cross-cultural studies; to promote multicultural education; and to enhance international education relationships (Xu, 2011). The core of the Reciprocal Learning Program and the SSHRC Partnership Grant project rests in the reciprocity between educators, parents and students from both nations. This partnership has helped to shift the conversation from: comparison to collaboration; from obstacles to opportunities; and from limits to learning.

From Comparison to Collaboration

In 2012, the Organization for Economic Cooperation and Development (OECD) released results from the Program for International Student Assessment (PISA) which demonstrated a slide in Canadian students' ranking. At that time, the former Deputy Prime Minister John Manley was quoted in the Globe and Mail as saying that the performance of Canadian students was "on the scale of a national emergency" (Alphanso, 2013). This statement fueled a frenzy of media attention on the Canadian "math problem" and sparked controversy over the ways in which we can emulate the high-ranking Chinese education system.

One of the main foci of the media attention was on the way in which Chinese math teaching focused on "rote learning" which was erroneously positioned in opposition to "discovery learning." This drove a fruitless public debate, distracting conversations from a thorough analysis of the data and the learning that could have been garnered.

> ***Countries differ in such global characteristics as the centralization of educational policies, the organization and types of schools, and the success of efforts to provide universal access to education. The status of teaching in the society, the composition and mobility of the student population, and the extent to which external examinations determine one's life chances, all constrain the ways in which mathematics is taught and learned.***
>
> *(National Research Council, 2001, p. 31)*

Assessments like PISA can generate discussion, inferences and further investigation. There is unquestionably information to be uncovered. However, attempts at comparisons between the education practices of nations are at best interesting and at worst a red herring. When we examine practices in isolation of their context, we tell an incomplete and incoherent story. These comparisons fall drastically short of identifying which practices are responsible for student achievement. Therefore, we must dig deeper into the evidence in order to help guide our educational improvements.

The values of a nation inform their systems of education. What is taught, who is taught and who does the teaching are simple examples of how the ideals and structures of mathematics education are tied to the complex cultural conditions of each nation. Certainly, the learning experience in Canada is not the same as the learning experience in China; but the living experience in Canada is not the same as the living experience in China. Each country provides a unique context for mathematics learning and when we compare stories, our learning needs to be positioned in an understanding of this context.

The results from PISA and other international data identifies the Canadian (Ontario) education model as world leading with respect to critical criteria such as equity, inclusiveness and support for all learners – criteria which define our national values. Our educational system is also lauded for the richness, diversity and comprehensiveness of the curricula (Council of Ministers of Education of Canada, 2012).

Insights from the Project

"It is not about copying and borrowing; it is about relating and understanding" was a statement made by Dr. ShiJing Xu, Associate Professor, University of Windsor, during a presentation about the learning of the Reciprocal Partnerships Project (2016). One of the great understandings that has come from the project is this idea that mathematics education is rooted in a culture, and no one practice can be isolated and replicated with the expectation of similar results in student achievement.

Through conversation, educators are able to build a better understanding of practices that support student learning. These cross-cultural perspectives support new approaches to research on curriculum and their application in classrooms. The insights from the project participants are demonstrated through their reflections. Educators' feedback focused on to the overall social standard of mathematics. They noticed the prominent social standard of mathematics among their Chinese partners, and observed how this focus influences the systems within the schools. Our values identify our priorities. Thus, an intentional and thoughtful prioritization of mathematics education will certainly serve to direct our energy to its service.

In order to capitalize on the potential for improving mathematics, we need to understand the entire story. Although the data may start the discussion, the learning is in the details. Through our international partnerships, we gain insight and understanding. Once we appreciate the "why" and "how," we can move the conversation toward "let's try." *The learning* is the heart of this partnership, because when we learn together, we can learn far more than when we are learning alone.

The values of a nation inform their systems of education. What is taught, who is taught and who does the teaching are simple examples of how the ideals and structures of mathematics education are tied to the complex cultural conditions of each nation.

"It is not about copying and borrowing; it is about relating and understanding" by Dr. ShiJing Xu

The learning is the heart of this partnership, because when we learn together, we can learn far more than when we are learning alone.

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LINKS

Globe and Mail - What Shanghai Can Teach Us about Teaching Math
http://www.theglobeandmail.com/news/national/education/what-shanghai-can-teach-us-about-teaching-math/article17835021/?page=all

OECD - Programme for International Student Assessment (PISA)
https://www.oecd.org/pisa/

Doing Math with Your Child
http://www.edugains.ca/newsite/math/offeredotherlanguage.html

GREATER ESSEX COUNTY DISTRICT SCHOOL BOARD

Expertise of All

The GECDSB values mathematical expertise and believes in building content and pedagogical knowledge of all educators. A mathematics teaching model which values mathematics expertise for all teachers, supports the tenets of the GECDSB core beliefs. We believe it is the learner who will become the expert, and at the GECDSB we are *all* learners.

The Greater Essex County District School Board provides mathematics education that engages and empowers students through collaboration, communication, inquiry, critical thinking, and problem-solving, to support each student's learning and nurture a positive attitude towards mathematics.

GECDSB, A Vision for Mathematics, 2016

The purpose of these learning briefs is to share the research, discussion and insight garnered from the intensive work of the Greater Essex County District School Board's Math Task Force. These papers are rooted in the GECDSB core beliefs, These papers are rooted in the GECDSB core beliefs, the Full-Day Early Learning—Kindergarten program and the Ontario Mathematics Curricula for grades 1-8, 9-10, and 11 & 12. The briefs are meant to elevate, enrich and extend the discourse of mathematics education with the intention of encouraging a positive and productive disposition toward mathematics for all learners.

Each paper provides a list of sources to extend the professional conversation and enhance the learning. In addition, live links appear at the end of the papers with connections to various resources.

Core Beliefs & Understandings

All students can achieve high standards given sufficient time and support.

All teachers can teach to high standards given the right conditions and assistance.

High expectations and early intervention are essential.

Educators need to learn all the time and they need to be able to articulate both what they do and why they do it.

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Teaching expertise extends beyond content area knowledge. Pedagogical content knowledge is a highly specialized skill-set that differs from subject specific knowledge and general pedagogical knowledge (Shulman, 1987).

MATH TASK FORCE

2

EXPERTISE OF ALL

The National Council of Teachers of Mathematics (NCTM, 2000) has cited that teacher knowledge, attitide and skill are of central importance in the teaching of mathematics. It is therefore no surprise that the role of content expertise is a critical debate among educators, parents and policy makers. In order for our students to become successful citizens of the 21st century, it is vital that we educate children to become proficient mathematicians and our success is in large part determined by effective teaching. The concept of *mathematics teaching expertise* requires careful study, and a review of the research raises many significant considerations that need to be closely examined at a classroom, school and system level.

Experience, Experts and Expertise

In order to better understand the crux of the issue, we need to explore the concepts of experience, experts and expertise. According to John Hattie, Professor of Education and Director of the Melbourne Education Research Institute in Melbourne, Australia, experienced teachers are those who have years of practice and familiarity in teaching, however Hattie identifies that experience and experts are not necessarily one in the same. He states:

> *Experts and experienced teachers do not differ in the amount of knowledge they have about curriculum matters or knowledge about teaching strategies. But experts do differ in how they organize and use this content knowledge.* (Hattie, 2003)

Certainly within the content rich area of mathematics there is a desire to identify and leverage our expert teachers. Conversations continue about math experts and their roles in schools. In order to best serve the interests of our students we need to expand our definition of *expert* to include *expertise*. If an expert is only defined as someone who has formal education in a content area, then we are missing crucial aspects of teaching expertise.

The well-known work of Lee Shulman (1987) on pedagogical-content-knowledge (PCK) has long demonstrated that teaching expertise extends beyond content area knowledge. Shulman describes content as the "what" and pedagogy as the "how" of teaching. According to his work, pedagogical content knowledge is a highly specialized skill-set that differs from subject specific knowledge and general pedagogical knowledge (Shulman, 1987). Within the context of mathematics teaching we need to adopt a comprehensive definition of the term "expert" which is grounded in research and inclusive of all the domains of expertise.

The use of specialty mathematics teachers is an accepted practice in secondary schools and in some elementary schools who adopt a "rotary" model. This model can have advantages when specialty teachers have demonstrated expertise, but the limitations of this model must be critically considered. The drawbacks include logistical implications for staffing and scheduling as well as the isolation of mathematics instruction to specific blocks of time. This structure impairs the opportunity for meaningful integration of mathematics throughout the instructional day, and this integration is a central principle of the Ontario Mathematics Curriculum. In addition, this model restricts professional learning to only specialty teachers, creating significant long-term impacts on schools and a school-system (Gerretson, Bosnick & Schofield, 2008).

Students engage in mathematics learning throughout their years of elementary and secondary school. Effectively supporting this learning requires all teachers to continue to develop and refine their expertise in mathematics. It is critical for our schools and school system to support deeper and broader understanding of mathematics teaching and learning for *all* educators.

Democratization of Mathematics

The democratic values of education are echoed in the core beliefs of the Greater Essex County District School Board, which

state that "all students can achieve high standards given sufficient time and support," and that "all teachers can teach to high standards given the right conditions and assistance." A mathematics teaching model, which only values mathematics expertise for specific teachers, defies the tenets of the GECDSB core beliefs. In addition, a system that reserves math expertise for only a few perpetuates a culture in which it is acceptable to claim mathematical illiteracy.

Currently, we experience a cultural norm in which it is acceptable to state "I can't do math," however the same posturing is not accepted in literacy. It is uncommon to hear a person publicly announce one's illiteracy, saying "I can't read." In order to challenge these cultural norms and advance the current social standards of mathematics proficiency, we need to remain committed to our core beliefs and demonstrate through our actions as educators that we believe all children can learn math and all teachers can teach math.

Expertise as Proficiency

Expertise should be defined through the lens of math proficiency (National Research Council, 2001). Just as literacy is more than the mere decoding of words, proficiency in mathematics is more than the mere recall of tables, facts, and formulas. Mathematics proficiency as defined in the GECDSB Vision for Mathematics includes five interwoven threads of mathematics skill: adaptive reasoning, strategic competence, procedural fluency, conceptual understanding, and productive disposition. This definition of mathematics proficiency is research–based, comprehensive and reflects our most current understanding of what students need as 21st century learners *and* leaders. Yet, our current reality stands before us.

Mathematics teaching should not look the same as it did decades ago. Years of research has informed our current best practices. Teachers in today's classrooms need to teach math in a way that may be different from how they were once taught. Previous definitions of what it meant to "do and be good at math" have resulted in some people developing limited fluency of mathematical procedures and fragmented understanding of mathematical concepts. In addition, mathematics learning which was exclusively based on rule-learning, speed and accuracy, and devoid of conceptual connections, has given rise to math anxieties and fixed math mindsets (Boaler, 2015). The focus of GECDSB over the past several years has been on developing growth mindsets. Our current challenge is to extend this work to the other mathematical proficiencies in order to develop the expertise of all.

Building Excellence by Building Expertise

Each and every day, our teachers rise to meet the challenge of their calling. We are learners and we believe that "educators need to learn all the time and they need to be able to articulate both what they do and why they do it." Teachers require time, support and resources to continue, extend and sustain the great work which is happening across our system. We must value the expertise of our greatest resource – our educators.

We trust that through our collective and collaborative learning we will find the answers we seek. Expertise is built through learning, and learning is what sustains, improves and empowers us. The GECDSB believes in building the capacity of all educators. We believe that it is *the learner* who will become the expert...and *we are <u>all</u> learners*.

Effectively supporting the learning requires all teachers to continue to develop and refine expertise in mathematics.

In order to challenge these cultural norms and advance the current social standards of mathematics proficiency, we need to remain committed to our core beliefs and demonstrate through our actions as educators that we believe all children can learn math and all teachers can teach math.

Expertise should be defined through the lens of math proficiency: adaptive reasoning, strategic competence, procedural fluency, conceptual understanding, and productive disposition.

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LINKS

Seven Foundational Principles for Improvement in Mathematics, K–12
https://www.edu.gov.on.ca/eng/teachers/studentsuccess/FoundationPrincipals.pdf

National Council of Teachers of Mathematics
http://www.nctm.org/

Lucy West - Building Success in Mathematics
https://vimeo.com/153792153

Marian Small—The Art of Mathematics
https://vimeo.com/103956482

Marian Small—It's About Learning
https://vimeo.com/136761933

Cathy Bruce—Professional Learning Key Features
https://www.youtube.com/watch?v=gGgH3RMqg9U

GREATER ESSEX COUNTY DISTRICT SCHOOL BOARD

Rote versus Discovery: Moving the Discussion Forward

The conversation of mathematics proficiency cannot be framed in the context of rote versus discovery learning because neither defines nor describes mathematical proficiency. The GECDSB believes in an integrated approach to teaching and learning that is responsive to the individual needs of the learners and is rooted in a conversation about mathematical proficiency.

The Greater Essex County District School Board provides mathematics education that engages and empowers students through collaboration, communication, inquiry, critical thinking, and problem-solving, to support each student's learning and nurture a positive attitude towards mathematics.

GECDSB, A Vision for Mathematics, 2016

The purpose of these learning briefs is to share the research, discussion and insight garnered from the intensive work of the Greater Essex County District School Board's Math Task Force. These papers are rooted in the GECDSB core beliefs, the Full-Day Early Learning—Kindergarten program and the Ontario Mathematics Curricula for grades 1-8, 9-10, and 11 & 12. The briefs are meant to elevate, enrich and extend the discourse of mathematics education with the intention of encouraging a positive and productive disposition toward mathematics for all learners.

Each paper provides a list of sources to extend the professional conversation and enhance the learning. In addition, live links appear at the end of the papers with connections to various resources.

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Interestingly, what divides them is a common understanding of what it means to "do and be good at math." It is this shared definition of mathematical proficiency that ultimately bridges the divide.

The conversation of mathematics proficiency cannot be framed in the context of rote versus discovery learning because neither defines nor describes proficiency.

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2

ROTE VERSUS DISCOVERY: MOVING THE CONVERSATION FORWARD

The rote versus discovery debate has occupied public discussion for years. On either side of the argument stands a passionate group with extensive research that claims to support their position. Each group believes that mathematics is important. Each group wants what is best for students. Interestingly, what divides them is a common understanding of what it means to "do and be good at math." It is this shared definition of mathematical proficiency that ultimately bridges the divide.

Daniel Ansari, of the University of Western Ontario, is professor of psychology and Canadian Research Chair of Developmental Cognitive Neuroscience. His work uses behavioural research methods and neuro-imaging to build an understanding of how children learn about numbers. Ansari (2015) recently published a compelling article with the Canadian Education Association which called for a truce to the "math wars". Ansari (2015) drew attention to the "false dichotomy" that is the math wars, stating that "these two approaches are frequently painted as being completely distinct and diametrically opposed to one another, creating the perception that there is a need to side with one particular view of best practice in math education".

Within this conversation is an array of terminology; words and phrases that unless clearly defined, lead us to talk in circles. Our dialogue must begin by operationalizing the terms being used, or the discourse becomes futile. Ansari describes *rote learning* as being synonymous with the rehearsing or drilling arithmetic facts and *discovery learning* as incorporating the underlying principles of mathematics through hands-on activities and open-problem solving. In the scope of mathematics education we can see how both of these narrow views fall desperately short of defining mathematics proficiency. Neither gives us a start or end point. The conversation of mathematics proficiency cannot be framed in the context of rote versus discovery learning because neither defines nor describes proficiency. Through the article, Ansari repositions the conversation as one of procedural and conceptual knowledge and argues that both are important parts of mathematics. He also calls for education stakeholders to abandon these emotionally-charged debates and use evidence to inform their dialogue.

The Greater Essex County District School Board includes procedural fluency and conceptual understanding as part of its vision for mathematics, but extends the definition based on the broad research of the National Research Council publication, *Adding It Up* (2001). Proficiency in mathematics is defined as: procedural fluency, conceptual understanding, strategic competence, adaptive reasoning, and productive disposition. Based on this definition, our work becomes designing instruction that mobilizes a range of strategies in order to move students toward proficiency (National Research Council, 2001).

Mathematics Proficiency

I want my child to know her times tables. *Absolutely*. I want my son to understand the concept of number. *Of course*. I want my students to solve problems using multiple strategies. *Definitely*. I want my daughter to love and excel in math. *Certainly*. I want my students to think mathematically and be able to justify their thinking. *Yes, without a doubt!*

Proficiency in Mathematics cannot be defined by any one facet, application, strategy, or attitude. It is an interweaving of five competencies, each distinct but with no one strand encompassing the entirety (National Research Council, 2001). It is the entwining of the threads that becomes the framework for mathematics proficiency and this is grounded in the goals and expectations of the Ontario Curriculum grades 1-8: Mathematics (2005). The proficiencies have been described in great detail in the publication *Adding It Up*, where the authors boldly state:

> *The most important observation we make here, one stressed throughout this report, is that the five stands are interwoven and interdependent in the development of proficiency. Mathematical proficiency is not a one dimensional trait, and it cannot be achieved by focusing on just one or two of the strands. (National Research Council, 2001).*

The Five Threads of Proficiency

Skemp (1976) argued that it is not enough for students to understand *how* to perform various mathematical tasks; they must understand *why*. He used the term "relational understanding" and explained that it is an appreciation of the underpinnings, ideas and relationships in mathematics. The first of the threads of

proficiency is conceptual understanding, which is the *why* of math. It is the ability to understand mathematical concepts, operations, and relationships, and the contexts in which they are useful. For example, when considering a multiplication question such as 55x24, a person with conceptual understanding can see that the problem could be represented as repeated addition, or as the area of a quadrilateral, the number of seats in a theatre, and any other scenario they can conceive.

Students with conceptual understanding are able to arrange representations in a variety of ways and use these representations to build new ideas. They can discuss the similarities or differences among these representations and make connections between "clusters" of mathematical principles, laws and properties (National Research Council, 2001, p. 120).

Building on this idea is the second thread of procedural fluency. This is the skill of carrying out procedures flexibly, accurately, and efficiently, and understanding the context in which the procedures should be applied. In the example of 55x24, a person with procedural fluency may apply a known method such as organizing the numbers horizontally and carrying out a standard algorithm. Being able to estimate and complete mental computations is also an important part of procedural fluency. Students need to be efficient and accurate in performing basic computations and a good conceptual understanding helps to support procedural fluency.

In school mathematics, procedural fluency and conceptual understanding are sometimes positioned as opposing concepts. This could not be further from the truth. The authors of *Adding it Up* clarify:

> *Procedural fluency and conceptual understanding are often seen as competing for attention in school mathematics. But pitting skill against understanding creates a false dichotomy. As noted earlier, these two are interwoven. Understanding makes learning skills easier, less susceptible to common errors and less prone to forgetting. By the same token, a certain level of skill is required to learn many mathematical concepts with understanding, and using procedures can help strengthen and develop that understanding* (National Research Council, 2001, p. 122).

Being able to solve mathematical problems is a large part of what it means to be proficient in mathematics. The third thread of proficiency is strategic competence, which is the ability to formulate, represent and solve mathematical problems using effective strategies. Devising a strategy includes being able to manipulate the process of problem-solving by formulating and selecting approaches. Students with strategic competence will exhibit conceptual understanding when they select and organize their solution, and procedural fluency when they carry out their strategy with efficiency. Strategic competence is an integral part of procedural fluency because over time and with experience, students see the value of selectiveness and efficiency of procedures. For example, consider when it is useful to multiply instead of adding repeatedly. Students need to be able to "replace by more concise and efficient procedures, those cumbersome procedures that might at first have been helpful in understanding the operation" (National Research Council, 2001. p. 126).

The fourth thread of proficiency, adaptive reasoning, is the capacity for logical thought, reflection, explanation, and justification. It is not enough to just select and carry out a strategy. Deductive reasoning is used to make conclusions using facts, definitions, rules, or properties. Mathematics learning develops when people are able to articulate the proofs and mathematical decisions they made, including: why a certain strategy was selected, why it was the most effective, and how they know they were successful or not. With the assistance of representations, even young children can demonstrate their justifications and reasoning. It is important to consider that, "it is not sufficient to justify a procedure just once... Students need to use new concepts and procedures for some time and to explain and justify them by relating them to concepts and procedures they already understand" (National Research Council, 2001, p. 130).

There has been significant work done in the area of Mathematical Mindsets by leaders like Jo Boaler (2015), who explain how our beliefs are strongly tied to our behaviour. Thus, seeing mathematics as useful and worthwhile helps to empower children to engage deeply in their learning. The fifth thread, productive disposition, is an inclination to see mathematics as beneficial and valuable. It allows students to see where and how mathematics can be applied, not only to the world around them, but in service of the intrinsic beauty of the discipline. Productive disposition is a tenacious belief that mathematics is not arbitrary or irrelevant, but understandable and worth the effort.
Developing a productive disposition does not

Conceptual understanding is the ability to understand mathematical concepts, operations, and relationships, and the contexts in which they are useful.

Procedural fluency is the skill of carrying out procedures flexibly, accurately, and efficiently, and understanding the context in which the procedures should be applied.

Strategic competence is the ability to formulate, represent and solve mathematical problems using effective strategies.

Adaptive reasoning is the capacity for logical thought, reflection, explanation, and justification.

Productive disposition is an inclination to see mathematics as beneficial and valuable. It allows students to see where and how mathematics can be applied, not only to the world around them, but in service of the intrinsic beauty of the discipline.

Proficiency develops over time, with practice, instruction, feedback, support and opportunity. As educators we take up the challenge of synchronically developing each of the strands of proficiency from kindergarten through secondary school.

Our students need to learn mathematics, and they need mathematics to learn.

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mean that we eliminate obstacles and challenges. Instead, we capitalize on the other strands of proficiency and provide opportunities for students to make mathematics meaningful through their perseverance and enthusiasm.

Proficiency develops over time, with practice, instruction, feedback, support, and through opportunity. As educators we take up the challenge of concurrently developing each of the strands of proficiency from kindergarten through secondary school. Becoming proficient in mathematics *is the start and end point*. For too long we have rested on incomplete definitions of the purpose of school mathematics and have engaged in misleading and distracting quarrels.

Our Full-Day Early Learning—Kindergarten program and the Ontario Mathematics Curricula for grades 1-12 both identify and promote proficiency. They provide the anchor and direction for mathematics instruction in Ontario. The expectations identify the classroom actions and the interconnectedness of the threads. *Explore, represent, design, justify, solve, compare* — these verbs direct the actions of proficiency. Our curriculum clearly identifies what proficiency looks like in a classroom. The work of educators is to design mathematics instruction that builds the strength of each thread in order to weave a rich and robust tapestry of proficiency.

Our students need to learn mathematics, and they need mathematics to learn. In order to elevate the discourse of mathematics education, our conversations must be rooted in proficiency because it is this aim toward excellence which will facilitate students to excel in their applications of mathematics and position them to realize its boundlessness.

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LINKS

Dr. Chris Suurtamm—Planning Moves for Teachers
(https://vimeo.com/136750780)

Dr. Cathy Fosnot—Basic Fact or Conceptual Understanding : A False Dichotomy
(https://vimeo.com/104110510)

Dr. Cathy Fosnot—Conceptual Understanding and Procedural Fluency: We Need Both
(https://vimeo.com/137299162)

GREATER ESSEX COUNTY DISTRICT SCHOOL BOARD

Supporting All Mathematics Learners through Responsive Learning Environments

The GECDSB has high expectations for all learners. We understand that learners come with diverse strengths, needs and interests. It is critical that we close the achievement gaps and meet the needs of all learners. Through a responsive mathematics learning environment, we can create equitable learning contexts and significantly impact student achievement. The GECDSB believes that we can design learning environments that are supportive, enriching and responsive to the uniqueness of our students.

The Greater Essex County District School Board provides mathematics education that engages and empowers students through collaboration, communication, inquiry, critical thinking, and problem-solving, to support each student's learning and nurture a positive attitude towards mathematics.

GECDSB, A Vision for Mathematics, 2016

The purpose of these learning briefs is to share the research, discussion and insight garnered from the intensive work of the Greater Essex County District School Board's Math Task Force. These papers are rooted in the GECDSB core beliefs, the Full-Day Early Learning—Kindergarten program and the Ontario Mathematics Curricula for grades 1-8, 9-10, and 11 & 12. The briefs are meant to elevate, enrich and extend the discourse of mathematics education with the intention of encouraging a positive and productive disposition toward mathematics for all learners.

Each paper provides a list of sources to extend the professional conversation and enhance the learning. In addition, live links appear at the end of the papers with connections to various resources.

MATH TASK FORCE

"All children can achieve high standards given sufficient time and support."

Effective mathematics teaching supports student learning according to the differentiated needs of the learner.

In order to support all learners, researchers insist that the learning environment must match the needs, strengths and readiness of the learner.

MATH TASK FORCE

2

SUPPORTING ALL MATHEMATICS LEARNERS THROUGH RESPONSIVE LEARNING ENVIRONMENTS

The core beliefs of the Greater Essex County District School Board express the heart of teaching and learning. Our beliefs define our action, set our direction and determine our success. The GECDSB believes that "all children can achieve high standards given sufficient time and support." When we carefully examine the dimensions of "time and support" we are led to an understanding of the critical role that mathematics learning environments play in supporting all learners.

Understanding Achievement Gaps

Achievement gap is a widely used term which refers to the discrepancy in academic achievement of identifiable groups of students. *Learning for All: A Guide to Effective Assessment and Instruction for All Students (2013)* is an Ontario Ministry of Education publication which guides and supports school and system planning by addressing effective means of reaching all learners. It states:

> *Gaps in achievement can be measured in terms of various factors, such as gender, ethnocultural background, socio-economic status, special education needs, language proficiency, or number of credits accumulated by the end of a particular grade. Achievement gaps can also be defined according to combinations of these factors, such as gender and special education needs, or gender and socio-economic status, or ethnocultural background and credit accumulation by year and grade. (p. 11)*

Research suggests that background influences, specifically socio-economic status and parental involvement, play an important role in student achievement (Learning for All, 2013). These factors influence student *readiness to learn* and these levels of readiness are genuine realities of every classroom. Research also suggests that learning environments which are safe, supportive and meet the needs of students are a means of creating equitable contexts and have a significant impact on student achievement (Jensen, 1998; Marzano, 2003).

Certainly there are conditions over which educators have limited control. Our efforts are best applied, however, to those factors over which we do have significant influence. We can explicitly and methodically design learning environments that are supportive, enriching and responsive to the uniqueness of our students.

Effective mathematics teaching supports learning according to the differentiated needs of the student. In order to support *all* learners, researchers insist that the learning environment must match the needs, strengths and readiness of each student. In order to overcome the disparities in achievement, we must address *learning gaps*, which is a term "often used to refer to the gap between a student's actual achievement and his or her potential for achievement" (Learning for All, 2013). Our responsibility is to address these learning gaps with precision and intentionality.

Building Responsive Learning Environments

A learning environment includes the physical and social contexts in which students learn. These settings have a profound impact on the experiences of the learner. The Literacy and Numeracy Secretariat (2012) states that a responsive learning environment encompasses the physical and social-emotional environment which include such elements as student voice, collaborations, focus on solutions, real-world problem solving, and self-efficacy. The Department for Education and Skills in the UK explains that the learning environment is made up of three factors that overlap and impact each other: ethos, behaviours and routines, and the physical environment. Hannah (2013) identifies that the learning environment is affected by physical elements, emotional elements, and intangible elements such as the energy of the classroom, rules and sounds. Fraser (2012) defines the learning environment as

"the social, psychological, and pedagogical contexts in which learning occurs and which affects student achievement and attitudes."

Based on the literature, it can be surmised that a responsive learning environment includes three realms: the Physical Realm, the Social and Emotional Realm, and the Choice and Voice Realm (Figure 1).

When considering the Physical Realm, educators look at the space of the classroom that promotes collaboration through group work as well as the space that permits quiet thinking and exploring of math. Active areas for inquiry, investigation and wonder are also considered to be part of the Physical Realm. When students are involved in the process of creating their own learning environment they can develop a sense of community and increased motivation.

When educators work to foster the Social and Emotional Realm, students feel safer to take risks in math class so that they can make mistakes while trying new ideas and strategies. Students also feel safer to revise their ideas and develop new mathematical understandings. When students feel supported by educators, they develop a more positive attitude towards math. Students feel they learn better in a "togetherness" learning environment that provides them with a sense of community. Furthermore, when students have more opportunities to independently explore and inquire, they feel more connected to the classroom community. In these classrooms, students not only hold more positive attitudes toward math, but they demonstrate higher achievement in math (Yang, 2015).

Students need to feel they have a "choice and voice" in their learning. The Choice and Voice Realm is key in creating a responsive math learning environment that encourages diverse thinking perspectives and ideas that are valued as ways to deepen mathematical understanding. Students have choice in exploring mathematics by choosing tasks, tools, methods, and partners. Students need to engage in tasks that challenge their current understandings and therefore have multiple entry points to meet the needs (Suurtamm, Quigly, & Lazarus, 201; Boaler, 2015).

An effective mathematics learning environment is determined by many factors and is influenced by all levels of educational organizations. Thus, decisions at all levels and by all stakeholders must take heed of the impact of these on the learning environment.

Each and every school day our classrooms are filled with students who bring the uniqueness of their individual stories to their learning. Each and every day we work together to write the pages of these stories. Planning these settings with purpose and intentionality is one way in which we can constructively shape the success of the stories our students will tell.

Figure 1

...a responsive learning environment includes three realms: the Physical Realm, the Social and Emotional Realm, and the Choice and Voice Realm.

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LINKS

Guides to Effective Instruction
http://www.edugains.ca/newsite/math/guides_effective_instruction.html

The Third Teacher
http://www.edugains.ca/resourcesLNS/Monographs/CapacityBuildingSeries/CBS_ThirdTeacher.pdf

Describing an Effective Learning Environment
http://www.edugains.ca/newsite/math/learningenvironments.html

GREATER ESSEX COUNTY DISTRICT SCHOOL BOARD

The Basics about Back to Math Basics

The GECDSB believes that the current challenge for educators is teaching mathematics that is rooted in, but not limited to, the "basics." Although mathematics has a practical value as a life skill, it is also applied to an array of other disciplines and is a creative and abstract science of numbers, space, and relationships between objects. The current paradigm of mathematics education must to be grounded in a definition of *mathematical proficiency* and our conversations need to extend beyond fundamentals and aim toward excellence.

The Greater Essex County District School Board provides mathematics education that engages and empowers students through collaboration, communication, inquiry, critical thinking, and problem-solving, to support each student's learning and nurture a positive attitude towards mathematics.

GECDSB, A Vision for Mathematics, 2016

The purpose of these learning briefs is to share the research, discussion and insight garnered from the intensive work of the Greater Essex County District School Board's Math Task Force. These papers are rooted in the GECDSB core beliefs, the Full-Day Early Learning-Kindergarten program and the Ontario Mathematics Curricula for grades 1-8, 9-10, and 11 & 12. The briefs are meant to elevate, enrich and extend the discourse of mathematics education with the intention of encouraging a positive and productive disposition toward mathematics for all learners.

Each paper provides a list of sources to extend the professional conversation and enhance the learning. In addition, live links appear at the end of the papers with connections to various resources.

MATH TASK FORCE

Basic understanding of mathematics is essential, and a necessary function of our schools is to prepare children with these foundational concepts and skills.

MATH TASK FORCE

2

THE BASICS ABOUT BACK TO MATH BASICS

We agree: math is everywhere and plays an important role in our lives. Basic understanding of mathematics is essential, and a necessary function of our schools is to prepare children with these foundational concepts and skills. The National Research Council's publication, *Adding it Up: Helping Children Learn Math,* articulates that, "(mathematics) is so much a part of modern life that anyone who wishes to be a fully participating member of society must know basic mathematics" (NCTM, 2001, p.15). In addition, a range of literature has demonstrated that early numeracy skills are a significant predictor of later academic achievement: perhaps even greater than early literacy skills (Duncan, Dowsett, Claessens, Magnuson, Huston, Klebanov, Pagani, Feinstein, Engel, Brooks-Gunn, Sexton, Duckworth, & Japel, 2007).

There is little argument that success in mathematics is imperative for 21st century learners, and most would agree that proficiency implies a foundation of basic mathematics. Yet the 'back to basics' argument continues in popular media, distracting public discourse from the deeper and significantly more complex issues of 21st century mathematics teaching and learning. Although teaching 'the basics' is a function of our schools, the real challenge for educators is teaching mathematics that is rooted in, but not limited to, 'the basics'. The current paradigm of mathematics education must be grounded in a definition of *mathematics proficiency* and our conversations need to extend beyond fundamentals and aim toward excellence.

Defining Mathematical Proficiency

The experience that we understand best is our own. Our experiences with mathematics are shaped by our learning and in turn our learning shapes our experiences. Depending on who you ask, the question of 'what it means to do math' is answered three different ways and each of these explanations has implications for the teaching and learning of mathematics. The first description refers to mathematics as an everyday skill. From basic banking to baking, we use mathematics to function in our everyday living. Although mathematics certainly has a practical value, there is significant danger in only defining mathematics as a 'life skill'. We do not define literacy as having a merely functional value. We expect students to develop an array of literacy skills that exceed a basic level. We believe that students should have access to rich texts with vivid discourse and critical thought. Why would we lower the bar for mathematics?

Mathematics is also distinct for its application to other disciplines, trades and professions. Modern areas of applied mathematics include medicine, business, technology, engineering and architecture as well as the sciences and others. Applied mathematics is not only relevant to most professions, it is crucial. People know and understand the math they experience in their professional lives, and sometimes reflect on this application as a definition of what it means to use and be skilled in mathematics.

Although both of these explanations are dimensions of math, they do not encompass the sum of mathematics as a creative, esoteric, abstract science of number and space. Mathematics is a rich and diverse discipline that dates to the beginning of recorded history. The goal of mathematics education should comprise this depth and richness. The Ontario Mathematics Curriculum states that:

Learning mathematics results in more than a mastery of basic skills. It equips students with a concise and powerful means of communication. Mathematical structures, operations, processes, and language provide students with a framework and tools for reasoning, justifying conclusions, and expressing ideas clearly (The Ontario Curriculum Grades 1-8: Mathematics, 2005).

The History of School Mathematics

The question of 'what should be taught in schools' has sparked debate by education philosophers since the time of Plato. During the first half of the 20th century, mathematics skill focused on computational procedures of arithmetic. In the 1950s and 1960s, the focus of mathematics education began to shift to include the structures of mathematics. From this shift was born the 'back to basics' movement which is described in *Adding it Up*, as "a returning to the view that success in mathematics meant being able to compute accurately and quickly" (National Research Council, 2001, p. 115). This view of mathematics as simply arithmetic computations is incomplete and incompatible with the modern goals of education. Basic skills of mathematics are developed in service of the richness of mathematics, but they are not its entirety.

The authors of, *Adding it Up* indicate that "recognizing that no one term captures completely all aspects of expertise, competence, knowledge and facility in mathematics, we have chosen *mathematical proficiency* to capture what we believe is necessary for anyone to learn mathematics successfully." The Greater Essex County District School Board's, Vision for Mathematics is based on the extensive evidence in mathematics education research that identifies five interdependent skill-sets which work together in the development of mathematical proficiency (Figure 1). Each of these strands represents distinct and important aspects of the whole of what it means to be proficient in mathematics.

Mathematics for 21st Century Learning

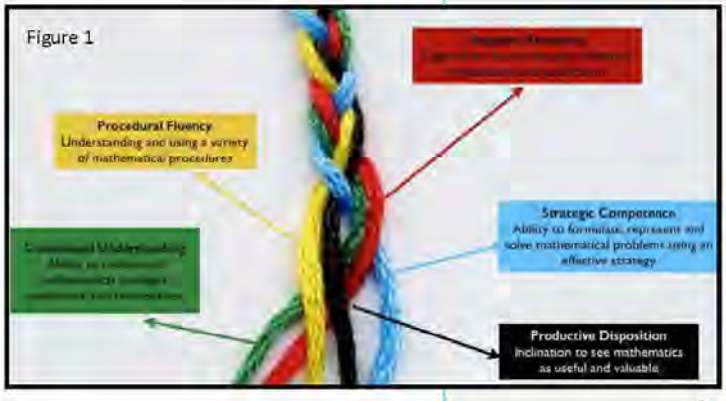
In order to inform practices and policies for school mathematics it is imperative that we look beyond our personal experience and critically examine evidence provided by research. Our Ontario Mathematics Curriculum grounds us in this conversation and states:

An information- and technology-based society requires individuals who are able to think critically about complex issues, analyse and adapt to new situations, solve problems of various kinds, and communicate their thinking effectively. The study of mathematics equips students with knowledge, skills, and habits of mind that are essential for successful and rewarding participation in such a society. To learn mathematics in a way that will serve them well throughout their lives, students need classroom experiences that help them develop mathematical understanding; learn important facts, skills, and procedures; develop the ability to apply the processes of mathematics; and acquire a positive attitude towards mathematics. (The Ontario Curriculum Grades 1-8: Mathematics, 2005)

We educate for excellence! We must extend our discourse to honour the essence of mathematics because in every classroom sits an artist, writer, builder, scientist and mathematician. It is the fullness of the educational experience that reaches the heart of every learner. Our purpose as educators is not to count the limited prospects but to inspire the infinite possibilities.

> ***If you deny students the opportunity to engage in this activity – to pose their own problems, to make their own conjectures and discoveries, to be wrong, to be creatively frustrated, to have an inspiration, to cobble together their own explanations and proofs – you deny them mathematics itself.***
>
> ***(Lockhart, 2009)***

Figure 1



...the real challenge for educators is teaching mathematics that is rooted in, but not limited to, 'the basics'. The current paradigm of mathematics education must be grounded in a definition of mathematics proficiency and our conversations need to extend beyond fundamentals and aim toward excellence.

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LINKS

MARIAN SMALL—THE ART OF MATHEMATICS
https://vimeo.com/103956482

CATHY FOSNOT—BASIC FACTS OR CONCEPTUAL UNDERSTANDING: WE NEED BOTH
https://vimeo.com/104110510

DAN MEYER—MATH CLASS NEEDS A MAKEOVER
http://www.ted.com/talks/dan_meyer_math_curriculum_makeover

CHRIS SUURTAMM—PLANNING MOVES FOR TEACHERS
https://vimeo.com/136750780

CATHY BRUCE—MATH TALK
https://www.youtube.com/watch?v=yplXNE4PRQQ

CREATING CONDITIONS FOR MATHEMATICS LEARNING
http://www.curriculum.org/k-12/en/projects/creating-the-conditions-for-learning-mathematics

DAN MEYER—REAL WORLD MATH
https://www.youtube.com/watch?v=jRMVjHjYB6w

GREATER ESSEX COUNTY DISTRICT SCHOOL BOARD

Key Competencies to Navigate the 21st Century Learner

Greater Essex County District School Board is dedicated to preparing all students for success. It is our belief that students must develop the necessary competencies to thrive in an ever-changing world. A current challenge for educators is knowing how to prepare students for their future where they will be asked to navigate a technologically advanced, globally connected and socially conscious world. GECDSB aims to create opportunities for students to develop their 21st century competencies through engaging classrooms and experiential learning opportunities. The GECDSB Math Vision promotes the learning of mathematics in a way that fosters creativity, communication, collaboration and problem solving.

> *"The Greater Essex County District School Board provides mathematics education that engages and empowers students through collaboration, communication, inquiry, critical thinking, and problem-solving, to support each student's learning and nurture a positive attitude towards mathematics."*
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MATH 2.0 TASK FORCE

GREATER ESSEX COUNTY DISTRICT SCHOOL BOARD

BUILDING TOMORROW TOGETHER. EVERY LEARNER, EVERY DAY.

"Today, schools need to prepare students for more rapid economic and social change than ever before, for jobs that have not yet been created, to use technologies that have not yet been invented, and to solve social problems that we do not yet know will arise."
(Schleicher, 2016)

MATH TASK FORCE 2.0

Key Competencies to Navigate the 21st Century Learner

"Ontario is committed to helping every child and student achieve success and well-being. The primary goal of the province's education system is to enable students to develop the knowledge, skills, and characteristics that will lead them to become personally successful, economically productive, and actively engaged citizens. Researchers acknowledge that the need to engage in problem solving and critical and creative thinking has "always been at the core of learning and innovation". What's new in the 21st century is the call for education systems to emphasize and develop these competencies in explicit and intentional ways through deliberate changes in curriculum design and pedagogical practice. The goal of these changes is to prepare students to solve messy, complex problems – including problems we do not yet know about – associated with living in a competitive, globally connected, and technologically intensive world." (Ontario, 2016)

21st century competencies have measurable benefits for multiple areas of life and therefore are critical for all students.
(Ontario Ministry of Education, 2015)

"Research supports the need for today's students to engage in "deeper learning" – or learning that allows students to take what is learned in one situation and apply it to new situations. Deeper learning involves the interplay of the cognitive (thinking/ reasoning), intrapersonal (behaviour/ emotions), and interpersonal (communication/collaboration). Through the process of deeper learning, students develop 21st century competencies, which can be defined as knowledge and skills that are transferable." (Ontario Ministry of Education, 2016)

Figure 1: "21st century skills" grouped into three broad domains (National Research Council in Lai, 2012, p. 2)

Defining 21st Century Competencies

Taken from the 2017 "Framework of Global Competencies" document created by the Ontario Ministry of Education, the competencies are defined below:

Critical Thinking and Problem Solving

Critical thinking and problem solving involve addressing complex issues and problems by acquiring, processing, analyzing and interpreting information to make informed judgments, decisions and actions. The capacity to engage in cognitive processes to understand and resolve problems includes the willingness to achieve one's potential as a constructive and reflective citizen. Learning is deepened when situated in meaningful, real world, authentic experiences.

Communication

Communication involves receiving and expressing meaning (e.g., reading and writing, viewing and creating, listening and speaking) in different contexts and with different audiences and purposes. Effective communication increasingly involves understanding both local and global perspectives, societal and cultural contexts, and adapting and changing using a variety of media appropriately, responsibly, safely, and with regard to one's digital footprint.

Collaboration

Collaboration involves the interplay of the cognitive (including thinking and reasoning), interpersonal, and intrapersonal competencies necessary to participate effectively and ethically in teams. Ever-increasing versatility and depth of skill are applied across diverse situations, roles, groups, and perspectives in order to co-construct knowledge, meaning, and content, and learn from, and with, others in physical and virtual environments. (Ontario, 2016)

Creativity and Innovation

Innovation, creativity, and entrepreneurship involve the ability to turn ideas into action to meet the needs of a community. The capacity to enhance

concepts, ideas, or products to contribute new-to-the-world solutions to complex economic, social, and environmental problems involves leadership, taking risks, independent/unconventional thinking and experimenting with new strategies, techniques, or perspectives, through inquiry research. Entrepreneurial mindsets and skills involve a focus on building and scaling an idea sustainably.

Self-Directed Learning

Self-directed learning means: becoming aware and demonstrating agency in one's process of learning, including the development of dispositions that support motivation, perseverance, resilience, and self-regulation. Belief in one's ability to learn (growth mindset), combined with strategies for planning, monitoring and reflecting on one's past, present, and future goals, potential actions and strategies, and results. Self-reflection and thinking about thinking (metacognition) promote lifelong learning, adaptive capacity, well-being, and transfer of learning in an ever-changing world.

Citizenship

Citizenship involves understanding diverse worldviews and perspectives in order to address political, ecological, social, and economic issues that are crucial to living in a contemporary, connected, interdependent, and sustainable world. It also includes the acquisition of knowledge, motivation, dispositions, and skills required for an ethos of engaged citizenship, with an appreciation for the diversity of people, perspectives, and the ability to envision and work toward a better and more sustainable future for all.

(Ontario Ministry of Education, 2017)

21st Century Competencies and the GECDSB Math Vision

GECDSB fosters the development of 21st Century competencies, as demonstrated through the Math Vision. With a focus on productive disposition and learning through problem solving, students are positioned to tackle rich tasks using a variety of strategies.

With a focus on productive disposition (the habit of seeing mathematics as sensible, useful, and worthwhile with a belief in diligence and one's own efficacy, National Research Council, 2001), GECDSB has been committed over the years to the development of a "Growth Mindset". Professional development has been centred around strategies supported by research from Carol Dweck and Jo Boaler. Instruction at GECDSB has been rooted in problem solving through rich tasks. *Principles to Actions* defines a meaningful task with a high level of cognitive demand "(as a tasks that allows) students to engage in active inquiry and exploration or encourage students to use procedures in ways that are meaningfully connected with concepts or understanding." (NCTM, 2014) The ability for students to select and justify their strategy supports critical thinking and students become the authors of their learning. As John Hattie states in Visible Learning in Mathematics, "School is a time to apprentice students into the act of becoming their own teachers. We want them to be self-directed, have the dispositions needed to formulate their own questions, and possess the tools to pursue them. In other words, as students' learning becomes more visible to them, we want it to become the catalyst for continued learning, whether the teacher is in the room or not." (Hattie, 2017) As we move away from a teacher directed learning environment, students are being asked to think as they make sense of and solve complicated math problems. The teacher's role in this environment is that of co-learning and facilitator, as they press students to think deeply and encourage connections through purposeful questioning. With the promotion of collaborative problem solving, students are also developing their interpersonal skills, including conflict resolution and see the benefit of considering the collective knowledge of the group and different perspectives. The consolidation of math learning allows students to engage respectfully in discourse where they analyze and critique other students' thinking in order to deepen their understanding and support the learning of others. "Students must also have opportunities to talk with , respond to, and question one another a part of the discourse community..."(NCTM, 2014)

"Changing times are transforming the nature of competencies that have been valuable throughout history, such as communication and collaboration."
(Ontario Ministry of Education, 2016)

"There is a growing body of research (Dweck, 2010; Duckworth, Matthews, Kelly, & Peterson, 2007; Tough, 2012) demonstrating that non-academic, intrapersonal competencies such as perseverance, grit, tenacity, and a growth mindset have a strong relationship with an individual's capacity to overcome challenges and achieve long-term success."
(Ontario Ministry of Education, 2016)

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LINKS

ONTARIO MINISTRY OF EDUCATION – Framework of Global Competencies
http://www.edugains.ca/resources21CL/21stCenturyLearning/FrameworkofGlobalCompetencies_AODA.pdf

FULLAN AND LANGWORTHY – A RICH SEAM
http://www.michaelfullan.ca/wp-content/uploads/2014/01/3897.Rich_Seam_web.pdf

THE LEARNING EXCHANGE - Deep Learning in a Digital World
http://thelearningexchange.ca/projects/deep-learning-digital-world/

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Implementing Change In Mathematics Pedagogy

Moving a system in mathematics requires vision but it also requires action. The GECDSB Vision for Mathematics (2015), is based on the work of the National Research Council, Adding It Up (2001) which defined mathematics excellence as five interwoven proficiencies. Math proficiency is about the collective composition of procedural fluency, conceptual understanding, adaptive reasoning, strategic competence and productive disposition. In the last several years, the primary focus the GECDSB has been on building capacity in developing the mathematical content-pedagogy of all educators. Research is clear that student proficiency is rooted to effective mathematics teaching practices. Moving forward, our collective work will become the implementation of effective practice for every student, in every classroom, every day.

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>
> GECDSB, A Vision for Mathematics, 2016

The purpose of this research brief is to share the research and insight garnered from the continued work of the Greater Essex County District School Board's Math Task Force. These papers are rooted in the GECDSB core beliefs, the Full-Day Early Learning—Kindergarten program and the Ontario Mathematics Curricula for grades 1–8, 9–10, and 11 & 12. The briefs are meant to elevate, enrich and extend the discourse of mathematics education and content pedagogy with the intention of encouraging a positive and productive disposition toward mathematics for all learners.

Each paper provides a list of sources to extend the professional conversation and enhance the learning. In addition, live links appear at the end of each paper with connections to various resources.

MATH TASK FORCE 2.0

"An excellent mathematics program requires effective teaching that engages students in meaningful learning through individual and collaborative experiences that promote their ability to make sense of mathematical ideas and reason mathematically"
(National Council of Teachers of Mathematics- NCTM, 2014)

MATH TASK FORCE 2.0

Ambitious and ***necessary*** are the words often used to describe the required journey to achieving excellence in mathematics. These two important words were first articulated by the authors of Adding it Up and they encapsulate the gravity of the current paradigm shift required to achieve mathematics learning success (National Research Council, 2001). The task of changing mathematics education in every school is ambitious and necessary, and having a greater understanding of the implementation of effective practice will assist leaders in moving their schools toward the desired vision.

Effective Mathematics Teaching

An excellent mathematics program requires effective teaching that engages students in meaningful learning through individual and collaborative experiences that promote their ability to make sense of mathematical ideas and reason mathematically (National Council of Teachers of Mathematics- NCTM, 2014).

Teaching is complex. Mathematics teaching is incredibly complex. Therefore mathematics teachers require a specialized skill-set which was first defined by Lee Shulman as content-pedagogy (1987). Mathematics teachers require both, a deep understanding of the mathematics and of pedagogical strategies that support student learning across the learning continuum. The question is, how do we define the elements of effective practice?

In 2014, NTCM published Principles to Actions. This document filled the gap between pedagogy and policy. Essentially, effective instruction outlined in the eight practices defined by researchers provide a framework for teaching and learning (Figure 1).

Principles to Actions illustrates the teaching practices that support mathematics learning of all students. The work now becomes ensuring the implementation of these practices in all classrooms (NCTM, 2014). Developing the content-pedagogy of all educators is part of the change process, but it is not the only way leaders lead change in schools. Informed decisions around timetabling, scheduling, resources, technology and communication, all support the overall goals.

Leading A Change In Instruction

Improving student outcomes is the work of all educators. Leading, supporting and monitoring changes in instruction is the work of leaders. Over the last few years, the focus of school improvement has included content foci like Proportional Reasoning, Fractions and Spatial Reasoning. These have provided a lens for content-pedagogy learning and are still necessary as we move forward; however, the challenge for school leaders continues to be implementation and monitoring. *How does a school leader measure the implementation of proportional reasoning? How do we monitor the effectiveness of fractions? Simply put, we cannot. Moving a school in mathematics must include the implementation and monitoring of effective instruction. For the purpose of this paper, we will construct an example in which a school's implementation goal is focused on improving students' understanding of fractions. An implementation approach would consider that, "effective teaching of mathematics engages students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem solving" (NCTM, 2014 p. 10). School leaders would monitor this practice as teachers engage in learning about varied models and representations. Leaders would also make a range of other decisions that support implementation of effective practice, for example purchasing the appropriate resources/ manipulatives. They would monitor how this change in practice and the use of resources impacts student understanding of fractions and then identify how deeply this practice is being implemented across the school. This illustration demonstrates the implementation of effective practice as observable, measurable and actionable.*

The Vision

Beliefs influence the decisions made across systems and researchers identify that the current "dominant cultural beliefs about the teaching and learning of mathematics continue to be obstacles to consistent implementation of effective teaching and learning in mathematics

Mathematics Teaching Practices
Establish mathematics goals to focus learning. Effective teaching of mathematics establishes clear goals for the mathematics that students are learning, situates goals within learning progressions, and uses the goals to guide instructional decisions.
Implement tasks that promote reasoning and problem solving. Effective teaching of mathematics engages students in solving and discussing tasks that promote mathematical reasoning and problem solving and allow multiple entry points and varied solution strategies.
Use and connect mathematical representations. Effective teaching of mathematics engages students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem solving.
Facilitate meaningful mathematical discourse. Effective teaching of mathematics facilitates discourse among students to build shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments.
Pose purposeful questions. Effective teaching of mathematics uses purposeful questions to assess and advance students' reasoning and sense making about important mathematical ideas and relationships.
Build procedural fluency from conceptual understanding. Effective teaching of mathematics builds fluency with procedures on a foundation of conceptual understanding so that students, over time, become skillful in using procedures flexibly as they solve contextual and mathematical problems.
Support productive struggle in learning mathematics. Effective teaching of mathematics consistently provides students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas and relationships.
Elicit and use evidence of student thinking. Effective teaching of mathematics uses evidence of student thinking to assess progress toward mathematical understanding and to adjust instruction continually in ways that support and extend learning.

Figure 1: Mathematics Teaching Practices
(Principles to Actions : Ensuring Mathematical Success for All. Reston, VA :NCTM, National Council of Teachers of Mathematics, 2014. Print.

classrooms" *(Handal 2003; Philipp 2007). Developing a clear understanding of what it means to do and be good at math what defined the early shift across the GECDSB.*

Setting direction through the GECDSB Vision not only established a clear picture for our future, it also served to challenge and reshape long-held beliefs about mathematics and mathematics learning. Beliefs drive behaviour, and so a view that mathematics learning should engage students in discourse, reasoning, and problem solving that facilitates a deep understanding of mathematical procedures and concepts stands in stark contrast to a traditional view.

Students' perception of themselves as learners of mathematics is directly tied to their experiences. Developing a productive disposition toward mathematics requires that students engage in learning that is worthwhile, meaningful and connected. Creating learning experiences that support this view requires an approach rooted in problem solving, sense making, reasoning, representation and justification. The GECDSB Vision constructs a view of mathematics teaching and learning that is grounded in research and has served as a catalyst for change across the system. The GECDSB Vision should always underpin our actions. Asking whether our decisions get us closer to our vision is our litmus test and the answer must always be, yes.

Implementation and Change

"Change is a process, it is not an event" is the opening subtitle of Gene Hall and Shirley Hord's first principle of change (2006). Our work over the last few years in the GECDSB suggests that there are common themes to the implementation

"effective teaching of mathematics engages students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem solving."
(NCTM, 2014 p. 10)

"dominant cultural beliefs about the teaching and learning of mathematics continue to be obstacles to consistent implementation of effective teaching and learning in mathematics classrooms"
(Handal 2003; Philipp 2007)

of the eight-practices and that our own case study helps us understand how this process is unfolding in schools. Effective monitoring will no doubt provide continuous insight into our collective progress and the impact it has on student learning.

Hall and Hord's research on change helps us to understand that it occurs over time and so we must be strategic in our change planning. Research confirms that the change process happens over years. In fact, "most changes in education take three to five years to be implemented at a high level" (Hall and Hord, 2006 p. 4). Although the process takes time, the authors also identify that deliberate and intentional planning helps to hasten the course. They also acknowledge that ignoring critical elements of change will impede the process by years (Hall and Hord, 2006).

Implementation of effective practice happens through professional learning and improvements in educators' content-pedagogy. Change happens through learning. It does not occur in one sweeping memo, an impassioned speech or a well-written paper. Change happens through the collective efforts of educators working tenaciously toward a clear goal.

Change is something that leaders know and understand. The daily work of leaders is knowing when to nudge and when to pull back. Leaders leverage the expertise in their building and make decisions designed to support student learning. The collective leadership experience in the GECDSB is considerable and impressive. Our leaders have led many changes in education and have constructed a system of innovation and creativity. Tapping into our current expertise will reveal that we have significant knowledge of how to lead, support and monitor change in instructional practice. The lens of implementation of the eight-practices will serve leaders well, as they move their schools ever toward the vision.

Strategic moves to communicate the GECDSB Vision helped to challenge and change beliefs of educators, students and parents. Focused professional learning challenged previous understandings of mathematical concepts and ideas and inspired countless conversations about arrays, relational rods and number lines in classrooms and staff rooms across the system.

There is no way forward that does not include challenge. As a young, budding mathematician recently stated "I love a good problem. It is prickly and tricky and takes all of my focus. A good problem is a problem worth solving. You need perseverance, creativity, collaboration, and a great teacher." Fortunately for our students, the GECDSB has all of these.

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GREATER ESSEX COUNTY DISTRICT SCHOOL BOARD

Small Group Instruction For Targeted Mathematics Intervention

Within the literacy block, small group instruction has become a strategy that consistently allows teachers to meet the learning needs of their students. In schools across Ontario, it is a regular practice that students participate in small group instruction to foster the development of their reading and writing skills. Research suggests that individualized and differentiated instruction is a high yield strategy to meet the needs of diverse learners within the classroom and it is a widely accepted approach for early literacy intervention. Assessment plays a key role in delivering effective small group instruction. Knowing the entry point of each student allows teachers to make informed decisions about instructional moves to best address student learning need. Diagnostic and formative assessment equips teachers with the necessary information to maximize their small group time and alleviates much of the guesswork. Every minute of individualized instructional time with students is valuable; being informed helps teachers maximize their impact as they select "just right" and differentiated intervention strategies. Belief around the impact and necessity of small group instruction in literacy is undisputed. However, surprisingly, this instructional strategy has been slow to transfer as a norm within the mathematics classroom.

> *"The Greater Essex County District School Board provides mathematics education that engages and empowers students through collaboration, communication, inquiry, critical thinking, and problem-solving, to support each student's learning and nurture a positive attitude towards mathematics."*
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The purpose of these learning briefs is to share the research, discussion, and insights garnered from the intensive work of the Greater Essex County District School Board's Math Task Force. These papers are rooted in the GECDSB core beliefs and in Ontario Ministry of Education documents as well as the Ontario Mathematics Curriculum (2005). They are meant to elevate, enrich and extend the discourse of mathematics education with the intention of encouraging a positive and productive disposition toward mathematics.

Each paper provides a list of sources and resources to extend the professional conversation, and enhance the learning. In addition, live links appear at the end of each paper, with connections to various resources.

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"Guided math enhances student learning as lessons are designed for the learner and what the student needs at that moment in time" (Ontario Teacher's Federation, 2019).

SMALL GROUP INSTRUCTION: A NECESSARY COMPONENT OF EFFECTIVE MATHEMATICS INSTRUCTION

Building upon on our experience in literacy, the foundational components, structures, and belief around the effects of small group instruction have already been established. Researchers have begun to investigate mirroring this instructional approach in mathematics and monitoring the impact of small group instruction on mathematics development. "Small group reading instruction is ubiquitous in elementary schools. This type of intervention provides the opportunity for more tailored, individualized instruction, which may help to motivate as well as instruct students. It also provides greater opportunities for conversation and interaction among teachers and students. Prior research has demonstrated the efficacy of this approach for improving students' early literacy skills, yet small group instruction is used much less frequently for math" (Jacob et al. 2018).

The opportunity afforded by small group instruction in the math classroom is an additional opportunity to reach every student. "Guided math enhances student learning as lessons are designed for the learner and what the student needs at that moment in time" (Ontario Teacher's Federation, 2019.) It is also an opportunity to speak with students one on one in order to develop a better understanding of their mathematical thinking and to value their ideas. Mathematics researcher, Marilyn Burns suggests that speaking with students one on one is the only way to see their "mathematical soul." Through small group instruction, teachers can be responsive to student learning needs and create an environment that supports all students, but particularly those struggling in mathematics. "Educational research literature on the subject of supporting students who are struggling in mathematics suggests the need for differentiating instruction through individualization of content and strategies, conceptually based explicit instruction and questioning, visual representations, meaningful practice, scaffolding and math discussions." (Ball, S. et al., 2016)

ASSESSMENT DRIVES INSTRUCTION

At the core of small group instruction is the teacher's ability to differentiate for students based on their developmental readiness. In order to determine each student's entry point, diagnostic assessment is a key component to delivering effective remediation and targeted intervention through small group instruction. "One (purpose of a diagnostic assessment) is to provide the teacher with clarity regarding students' prior or prerequisite knowledge related to content that the upcoming learning segment is going to build upon. Assessing for prior knowledge can identify student misconceptions as well as gaps in knowledge and skills that a teacher might assume students of a particular grade level have already mastered" (Tomlinson et al, 2013). Effective diagnostic assessment should be used to determine an individualized path to address student-learning needs or to extend student thinking. "The teacher who consciously uses assessment to support learning takes in this information, analyzes it, and makes instructional decisions that address the understandings and misunderstandings that these assessments reveal" (Leahy et al. 2005, 19).

INVESTIGATING THE IMPACT OF SMALL GROUP INSTRUCTION IN MATHEMATICS THROUGH THE GECDSB SUMMER LEARNING PROGRAM

During the 2018 GECDSB Summer Learning Program (SLP), research was conducted to measure the impact of intentional and targeted small group instruction on student achievement in mathematics. 784 children participated in Summer Learning across a variety of programs and camps, which included 29 combined literacy and numeracy sites.

A core component of the Summer Learning Program is daily small group instruction in both literacy and numeracy. At the onset of the program, educators used Leaps and Bounds as a diagnostic assessment tool. "The resource is designed to assist teachers in providing precise, targeted remediation for these students (struggling in mathematics) – individually, in small groups, or as a whole class. With Leaps and Bounds, teachers can help students better understand the

prerequisite math so they can be successful in meeting the curriculum requirements for their grade. (Ball, S. et al., 2016) Primary students participating in the program were assessed in the content areas of counting, addition and subtraction. Sitting with students one on one in order to conduct the interviews gave educators insight into what students could do and helped educators identify students' individual next steps. Teachers used the diagnostic assessment and insight gained from the interviews to develop a plan for targeted remediation, equipping them with valuable information about the individual needs of their learners.

SUMMER LEARNING PROGRAM (SLP) CASE STUDY: IDENTIFIED STUDENT LEARNING NEEDS AND RELATED TEACHER ACTIONS

At a summer learning site, a grade 2 student was interviewed using the grade 1/2 Leaps and Bounds assessment which assesses gaps in prior knowledge related to the K-1 curriculum. As the educator asked a series of questions related to counting, the student demonstrated the ability to rote count by ones to 20. He also counted by groups of twos to ten and counted by 5s to 20. He was unable to conceptually subitize numbers larger than 5, instead he relied on his one to one counting skills. He struggled to count backwards by any unit with accuracy. For example, "pick a number from 5 to 15, count backwards to 0 from your number."

When it came to addition and subtraction, the student did not independently demonstrate any thinking strategies. He often randomly guessed a sum or difference. With some prompting, he was able to use his fingers or the visual prompts to find small sums using one to one counting. Of the 13 addition questions, the student answered 5 questions correctly. Through the subtraction questions, it was evident that the student did not understand the concept of subtraction, even in context. For example, when asked to determine whether there were enough bones for the number of dogs, he could not demonstrate the ability to match the dogs and bones one to one in order to determine the difference. The student's inability to count backwards also presented a challenge for successfully answering the subtraction problems. For example, "put 17 cubes on the 10 frame, take away 1 at a time and count backwards". Of the 13 questions in the subtraction portion of the assessment, the student answered two questions correctly.

Equipped with this information through the Leaps and Bounds assessments, the teacher was able to create a targeted intervention plan based on the student learning needs which was facilitated daily over the course of 3 weeks. The educator developed a plan to target conceptual subitizing through the use of dot plates, ten frames and the arithmetic rack. The student practiced counting backwards by units of 1, 2 and 5 from 20 to 0 daily using the arithmetic rack and a number line. The teacher also focused time during small group instruction with this student on the "part-part whole" model to make sense of different contexts related to the operations of addition and subtraction. The teacher encouraged the student to model all contexts using concrete materials on the part-part whole mat. The student also worked on finding the difference in comparison subtraction problems using a concrete linear model. On the post assessment, the student demonstrated a variety of strategies and independently used models including the ten frame, the part-part whole mat and a concrete linear model as tools for thinking. The post assessment data for this particular grade 2 student is recorded in the table below.

ASSESSMENT TOOL	PRE	POST
Counting	8/13	13/13
Addition	5/13	12/13
Subtraction	2/13	11/13

Throughout the GECDSB Summer Learning Program, many of the students involved in the program demonstrated gains in the three main content areas. 70% of the students in the sample demonstrated improvement in counting. 75% of the students demonstrated improvement in addition and 90% of the students demonstrated improvement in subtraction.

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The percentage of students scoring 80% or higher on each Leaps and Bounds assessment, gains that can be attributed to regular, focused, and targeted small group instruction based on diagnostic assessment are recorded in the table below.

ASSESSMENT TOOL	PRE	POST
Counting	50%	80%
Addition	65%	78%
Subtraction	20%	48%

Educators participating in the Summer Learning Program were asked to identify which factors they believe contributed to the gains measured through the pre and post assessments. The factors are ranked in the table below based on educator survey data.

1.	Co-Teacher/Educator Partnerships
2.	Consistent, precise, intentional small group instruction
3.	Use of diagnostic and formative assessment to monitor learning
4.	Use of available resources and manipulatives
5.	Inquiry approach
6.	Professional Development prior to Summer Learning Program

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CONCLUSION

The GECDSB will continue to support the regular integration of assessment based small group instruction as an essential component of the mathematics learning block. It is the belief of the GECDSB that individualized and responsive intervention, delivered through meaningful small group instruction, is a mechanism for early intervention, remediation, and success for all learners.

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GREATER ESSEX COUNTY DISTRICT SCHOOL BOARD

Experiencing Mathematics From Concrete to Abstract

Our youngest students come to school as curious learners whose life experiences inform their interests. With logic and reasoning, children make sense of the world around them through exploration, inquiry, play and collaboration. Four and five year olds demonstrate an innate ability to make connections and see patterns; in essence, young learners are able to see mathematics in the world around them through a sense of quantity, fairness, the recognition of patterns and rules. Mathematics is a subject where educators allow critical thinking to flourish. Students are encouraged to mathematize their world, and as facilitators of learning, educators help students represent their thinking more abstractly over time using the language of mathematics. Mathematics will foster the types of thinkers who will be vital to our world. What society needs is problem solvers. The GECDSB is committed to creating a learning environment that develops mathematical proficiency for all students, where thinking is encouraged in a mathematics classroom that promotes equity. One way to unlock this potential is making mathematics concrete.

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BUILDING TOMORROW TOGETHER, EVERY LEARNER, EVERY DAY.

"The math I remember in school was rigid. It wasn't about thinking, just rule following. But now I see, math is creative. In reality, it is beautiful and poetic. Math reminds me a lot of music. My school experience didn't give me a chance to see it."
(GECDSB Principal)

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Making Math Concrete

GECDSB has made a commitment to make math "concrete". Initial professional development was rooted in the research of the CRA (Concrete – Representation – Abstract) model. This model was developed to support students struggling in mathematics, particularly students with a designated learning disability. "CRA is a sequential three level strategy promoting overall conceptual understanding, procedural accuracy and fluency by employing multisensory instructional techniques when introducing the new concepts. Each level builds on the concepts taught previously." (Witzel, Riccomini & Schneider, 2008). CRA was a great starting point for teachers at the GECDSB. It was a way for educators to begin reconsidering how concepts were introduced and how to develop proficiency. Many teachers began asking themselves how to introduce the concept concretely with manipulatives. "A carefully planned mathematics environment enables the use of manipulatives whether commercial products or found objects, sometimes brought in by the students themselves. Ideally, manipulatives serve as learning tools to help students build their understanding and explain their thinking to others. Research has shown, however, that manipulatives themselves do not magically carry mathematical understanding. Rather, they provide concrete ways for students to give meaning to new knowledge." (Ontario Ministry of Education, 2011, p. 2)

Consider for a moment the procedure for calculating mean, a measure of central tendency. Traditionally, this concept was taught as a series of steps. Take all of the numbers in the data set, add them together, and divide by the number of numbers. This procedure seems relatively straightforward. However, in 2017, the Education Quality And Accountability Office (EQAO) Grade 6 Assessment of Mathematics presented students with the problem shown in figure 1.

Although the procedure for calculating the mean is relatively easy to memorize, students performed poorly on this

13 This table shows the heights of 6 players on a volleyball team.

Player Height

Player	Height (cm)
Chinua	138
Zaki	132
Baina	116
Bohumir	138
Nura	126
Leslie	130
Peter	?

If the mean height of all 7 players is 128 cm, which of the following is Peter's height?

- 138 cm
- 131 cm
- 130 cm
- 116 cm

Figure 1: Question 13 from the 2017 EQAO Grade 6 Assessment (EQAO Grade 6 Assessment Release Questions, 2017, p. 10)

question. At the GECDSB, 46% of students answered this question correctly. This question is an example of the necessity to introduce a concept concretely in order to develop conceptual understanding. It is difficult for students to memorize and work flexibly within a procedure. If they never really understood it beyond a series of steps that they were asked to follow.

Our understanding of "concrete" has evolved over the past few years to not only include the use of manipulatives, but to an expanded focus on the use of both concrete and visual representations. "Visual understanding is incredibly powerful for students, adding a whole new level of understanding... This can be provided through diagrams but also through physical objects, such as multilink cubes and algebra tiles" (Boaler, 2016). Leveraging the use of a variety of visual models has helped educators and students bridge their logical reasoning and sense making with representations that are more abstract.

Students in grade 2 determined how many cartons of eggs to purchase in order to have 60 eggs all together. They made sense of this problem using a concrete or visual representation (figures 3 and 4) that displayed one carton of 12 eggs at a time, and they counted on by ones and twos until they had 60 eggs in

Figure 2: A conceptual approach to solving Question 13 from the 2011 EQAO Grade 6 Assessment through bar models.

total. In reality, these grade 2 students divided 60 by 12 through quotative division.

Students could not articulate that the operator for this problem was division, but they all successfully solved a real world problem through logic and intuition, supported by their prior knowledge and a visual or concrete representation. The role of the educator is to help students gradually make connections between their visual representation and the more abstract notation based on their developmental readiness. "Knowledgeable educators help students transform their everyday mathematics into a more formalized understanding that can be transferred and applied to other situations. Several researchers refer to this as "mathematization" which requires students to abstract, represent and elaborate on informal experiences and create models of their everyday activities (Clements & Sarama, 2009, p. 244). The educator can play an integral role by making meaningful connections between the mathematical strands, the real world and other disciplines, and most importantly, "between the intuitive informal mathematics that students have learned through their own experiences and the mathematics they are learning in school" (Ontario Ministry of Education, 2011, p. 4).

The Impact

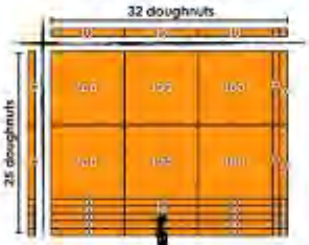
One intended outcome of starting concrete is accessibility. The mathematics classroom of the past typically had students who fell into two categories: students who were good at math and students who were not. The use of concrete and visual representations is a way to create equity in the math classroom, and provides an opportunity that supports the achievement of high levels of mathematics for all students. "When we open mathematics, we broaden the number and range of student who engage and do well. This is not an artificial broadening or dumbing down of mathematics; rather, it is a broadening that brings school mathematics closer to real mathematics and the mathematics of the world" (Boaler, 2016).

"Students who would normally struggle have hope, as they use concrete materials as tools to develop their conceptual understanding of mathematics. They are not overwhelmed by the numbers in the math or what to do with those numbers. Instead, they can conceptualize, manipulate and develop a concrete understanding of the mathematical concepts with which they are engaging. The concrete material becomes the bridge for students that helps them anchor their understanding to something tangible, that they have experienced personally, and gives them the confidence to take gradual steps over to the other side, to the realm of more abstract concepts and thinking" (GECDSB Teacher).

How Many Doughnuts Are There?

Concrete
Actual Doughnuts

Concrete Manipulatives:
Base 10 Blocks



Pictorial / Visual
Area Model: Partial Products

Abstract / Symbolic
Conceptual Algorithm

32
x 25
600
40
150
10
800

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Another perceived impact of starting concrete is the influence on student disposition towards mathematics. Students who formerly felt left out of the conversation or left behind can gain some footing, and in turn, a positive mindset around their mathematical ability. The use of concrete materials helps educators lower the floor on every single task. With the GECDSB commitment to the use of manipulatives, the stigma that manipulatives are designated for "those who can't" has begun to dissipate. "I used to feel really nervous about math. I didn't really understand most things and I felt like everyone else knew what to do and I didn't. Now that I know that I can use tools, and my friends use the tools too, I can figure it out. Math just makes so much more sense to me" (GECDSB student).

With an ongoing commitment to promoting the development of the Five Mathematical Proficiencies, identified by the National Research Council in Adding it Up – Helping Children Learn Mathematics, making the mathematics concrete is an approach to support the development of conceptual understanding for both educators and students. Educators were not taught math conceptually.

A focus on concrete and visual representations, allows, but also forces teachers to develop their own conceptual understanding of concepts in order to support student learning. "Teachers need to be able to reason through and justify why certain procedures and properties hold true, to talk about how mathematical language is used, to see the connections between mathematical ideas and to understand how they build upon one another" (Ontario Ministry of Education, 2011 p. 3). It is imperative that the mathematics can be "seen" to promote sense making and to reveal connections. In order for the math to be seen, teachers and students must determine how to model it. Through this process, all participants will engage in critical thinking, problem solving, and patterns and generalizations will be revealed, rather than told. "Each time one prematurely teaches a child something he could have discovered himself, that child is kept from inventing it and consequently from understanding it completely" (Fosnot, 2016).

Using the standard algorithm for multiplication in the Junior Division leaves some students behind and teachers frustrated. Teachers are left to wonder why student cannot remember the steps and why they do not know their facts. Student multiplying double digits forget to add the zero in the second row, and their answer is sometimes completely unreasonable. Teachers then ask the question, "How do students not see that that number doesn't make sense?" Students likely cannot see that the answer is unreasonable because the algorithm means very little to them. At GECDSB, professional development has been dedicated to understanding models and contexts that promote conceptual understanding of multiplication and the development of fact fluency.

Conclusion

The purpose of "making math concrete" is a gateway for creating equity through the development of conceptual understanding. It is an opportunity to make connections, encourage sense making and collaboration. The mathematics of the past was limiting in its ability to promote critical thinking and problem solving. It was reserved for the elite, the "gifted" and the good memorizers. But when the math can be seen, a greater opportunity is possible for all students to love mathematics and to see themselves as mathematicians. "The math I remember in school was rigid. It wasn't about thinking, just rule following. But now I see, math is creative. In reality, it is beautiful and poetic. Math reminds me a lot of music. My school experience didn't give me a chance to see it" (GECDSB Principal).

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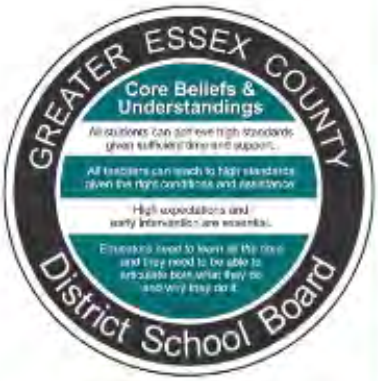
GREATER ESSEX COUNTY DISTRICT SCHOOL BOARD

Student Voice: Transforming School Improvement

The Greater Essex County District School Board (GECDSB) is a learning organization continuously striving to improve. The School Effectiveness District review process is consistently reflected upon and innovated to improve support for the school improvement process. Over the years, the district review process has moved from comprising of solely administrator teams to now also include the voices of educators and students in order to have the most impact on teacher professional learning, classroom practice and student achievement. Two protocols were designed for the purpose of the district review to support school improvement plan monitoring: Student Centred Learning Communities (SCLC) and Student Led Learning Walks (SLLC). The GECDSB believes when educators and students form genuine partnerships in the school improvement process the synergy of the work inspires learning for all.



> *"The Greater Essex County District School Board provides mathematics education that engages and empowers students through collaboration, communication, inquiry, critical thinking, and problem-solving, to support each student's learning and nurture a positive attitude towards mathematics."*
>
> GECDSB, A Vision for Mathematics, 2016

The purpose of this research brief is to share the research and insight garnered from the continued work of the Greater Essex County District School Board's Math Task Force. These papers are rooted in the GECDSB core beliefs, the Full-Day Early Learning—Kindergarten program and the Ontario Mathematics Curricula for grades 1-8, 9-10, and 11 & 12. The briefs are meant to elevate, enrich and extend the discourse of mathematics education and content pedagogy with the intention of encouraging a positive and productive disposition toward mathematics for all learners.

Each paper provides a list of sources to extend the professional conversation and enhance the learning. In addition, live links appear at the end of each paper with connections to various resources.

MATH 2.0 TASK FORCE

"Staff and students meet one another as equals, as genuine partners in th e shared understanding of making meaning to their work together" (Fielding, 2004, p.309).

MATH TASK FORCE 2.0

Focusing on successful implementation of school and district initiatives is a priority of the GECDSB. Over the past two decades, much has been written about the importance of student voice (Cook-Sather, 2006; Fielding, 2001, 2004, 2012; Fitzgerald, Graham, Smith & Taylor, 2010; Levin, 2000; Lodge, 2005, 2008; Mitra, 2006, 2008; Simmons, Graham & Thomas, 2015; Toshalis & Nakkula 2012). Student Voice has been explained as "a metophor for student engagement and participation in issues that matter to learning." (Ontario Ministry of Education, 2013, p.2). It is thought of as opportunities for students to voice their opinion and make decisions about topics that will influence their lives (Lodge, 2005; Mitra, 2006, 2008; Ontario Ministry of Education, 2013; Toshalis & Nakula, 2008).

STUDENT VOICE AND SCHOOL IMPROVEMENT

Student voice has often been thought of simply to discuss social constructs of schools, for instance lockers, food and dress code (Lodge, 2005, 2008; Mitra, 2008), but students are also capable of engaging in discourse about the pedagogy of learning (Lodge, 2005, 2008; Mitra, 2008). Mitra states, "Students have much to tell us about how best to reform our schools. To improve student achievement it makes sense to go straight to the source" (Mitra, 2008, p.20). A growing body of research describes the significant role student voice plays in school improvement efforts. (Cook-Sather, 2006; Levin, 2000; Lodge, 2005; Mitra; 2008; Ritchhart, 2015; Simmons et al.,2015) however, there is limited evidence about its impact (Levin, 2000; Simmons et al, 2015). Cook-Sather (2014, p.361) suggest that organizational structures and cultures are needed in order for student voice to become a lived reality in the school improvement process.

STUDENT VOICE CONTINUUM AND DISTRICT REVIEW

Different typologies have been developed that describe student voice activities from students viewed as data sources at one end to activists and leaders at the other (Fielding, 2001; 2012; Lodge, 2005; Mitra, 2006; Ontario Ministry of Education, 2013; Toshalis & Nakkula, 2012). Partnering with students through Student Work Study brought our Board's attention to the need to move along the student voice continuum to partner with students as co-learners and co-inquirers, not simply as mere data sources. Some students expressed feeling like objects of a study not as part of the study during the Student Work Study Initiative. As educators build partnerships with students, adults need to be cautious of the inherent hierarchy of power in order to develop equitable relations where both groups listen, hear and learn with each other (Fielding, 2001, 2012; Mitra, 2006). Through this joint work, new communities of practice can emerge (Fielding, June 2001).

The re-imagined District Review process was centred on student voice. Fielding's (June 2001, 2004, 2012) work on the student voice continuum has been the catalyst for the evolving District Review at the GECDSB. Our district was looking for a niche where "staff and students meet one another as equals, as genuine partners in the shared understanding of making meaning to their work together" (Fielding, 2004, p.309). Margery Ginsberg's work on the motivational framework inspired our process. Her Data-in-a-Day and Shadowing protocols (2011) shaped our work to gain a deeper understanding of the student learning experiences.

PROCESSES

The GECDSB designed two protocols to better understand the student learning experience in mathematics with colleagues from the same school, students, school superintendent and two learning partners from the program department: Student Centred Learning Communities (SCLC) and Student Led Learning Walks (SLLW).

The purpose of the classroom visit is to obtain a snapshot of the classroom in order to collect evidence based on the math focus in our board. An inherent belief in both protocols mentioned above is an asset –based approach to learning inside and outside the classroom. Partnerships are formed with students, teachers, and administrators for the purpose of monitoring school improvement plans. The visits are intended to be an open conversation between the team, teachers, and students.

The school visits occurred in the late fall and the late spring with a midpoint reflection gathering for all stakeholders involved. Following the spring visit, a focus group interview was conducted with four administrators and four teachers.

STUDENT CENTRED LEARNING COMMUNITIES

The school team consisted of two teachers who volunteered to host the observation team. The observation team consisted of two other teachers who were invited by the hosts along with the participants listed above. The visit was comprised of 30 minutes of classroom observation. Half the team documented the physical environment in the classroom, while the other half partnered with students to document their voice as they were engaged in the mathematics learning. Once the classroom visit was completed, the educators gathered to share important noticings by recording their observations and clustering them to form questions. These wonderings guided the conversation with student volunteers from each class. The students' voices were again recorded and posted for transparency. The school team reflected upon the data gathered at this point and recorded evidence that was connected to the pre-selected School Effectiveness Framework indicators found in the School Improvement plan (SIP) for student achievement. This process was repeated for a second observation followed by a ghost walk in the school. The ghost walk happened in the school hallways and classrooms where teachers had volunteered to welcome the team. The school team met for another half day to reflect upon the learning, the SEF evidence, and the SIP to uncover celebrations and areas for growth. Part of this time was spent to plan how the information will be shared with the school in order to allow more voices to identify the next steps.

STUDENT LED LEARNING WALKS

All school staff were briefed on the process, purpose and protocols of the Learning Walk. Select classrooms were chosen based on teacher volunteers. The walking team consisted of six teachers who volunteered and invited colleagues into their classroom. Additional teachers may have expressed interest in inviting the team to visit their classrooms. Participating teachers invited two students to be the Lead Walkers in their classrooms. The day was divided into three parts: Kindergarten –Primary division walk, Junior-Intermediate division walk , and reflection. During the Learning Walks, the team divided into two groups. One team entered classrooms and observed the physical environment, and the second team followed the Lead Walkers. The Lead Walkers were prompted: "Show us what helps your math learning in this classroom". Lead Walkers pointed out important things in their math classroom's physical environment that help them learn math. The visiting team documented what the Lead Walkers were saying. Once the classroom visit was complete, the process followed the same protocol as the SCLC.

"Participating in reform efforts increases student's agency, self-worth, respect and sense of membership in school" *(Mitra, 2008)*

MATH TASK FORCE 2.0

"Teachers cannot create new roles and realities with out the support and encouragement of their students; students cannot construct more imaginative and fulfilling realities of learning without a reciprocal engagement of their teachers. We need each other to be and become ourselves, to be and become better learners and teachers of each other together."
(Fielding, June 2001, p.108)

MATH TASK FORCE 2.0

REFLECTION MEETING

After the fall process, a meeting was held for the schools involved. A principal, one teacher, and two students attended the meeting from each school. Furthermore, all five school superintendents and the director of education were present at the meeting.

The purpose of the reflection was to engage in learning conversations with students, teachers and administrators; to discover common themes of celebrations and areas for growth in order to deepen our understanding of the math learning in our schools; and to brainstorm ways to spread, adapt and innovate important components of this process. Refer to the links on the back page for the video reflection.

FINDINGS

Quantitative and Qualitative data was collected using a variety of methods: a graffiti wall, presentations, a survey and a focus group interview.

GRAFFITI WALL

Both educators and students were given the opportunity to express how they felt about the visits. Both students and teachers reported feeling "nervous" at first, but all participants reported that the fear dissipated as they engaged in the process. Most teachers and students felt "inspired", "empowered", "proud" and "excited. " The educators' second activity was to identify any components that may have contributed to the impact of this structure on teaching and learning. The question was derived from anecdotal notes that were documented during the SCLC and SLLW visits. Educators identified the following components to be impactful: student voice, time, reflection, collaboration, de- privatization of practice and connection to the SIPSA. The students' second activity was to identify ways of including more student voice at their school. Students suggested forming group talks with varied groups of students, inviting more educators for classroom visits, and holding more meetings to include students in order to gain more comfort in sharing ideas.

PRESENTATIONS

Students were placed in mixed groups to collectively brainstorm ideas about what is important to their math learning. After their brainstorming, they were given the choice of presenting the work to educators in the form that best suited their learning style. Students were asked the question: "If you had a chance to convince educators that _____ is important, what would you say? Explain why". Their responses were presented in the form of songs, skits, and public service announcements. The presentations revealed the importance of manipulatives, group work, choice, and co-constructed anchor charts.

THEMES

Educators from each school were asked to share their celebrations and areas for growth that their school team determined after the SCLC or the SLLW visits. The celebrations and areas for growth from all schools were clustered according to their similarities. It was evident that the themes aligned with the responsive mathematics learning environment, which was researched during the Math Task Force last year. All the themes mentioned above fell into the three realms: Physical, Social & Emotional, and Choice and Voice. Furthermore, new themes that emerged were connected to professional learning. These themes encompassed the focus on the SIPSA, time to learn, continuity across grades and divisions and de-privatization of practice.

SURVEY

As mentioned in the literature review, many researchers (Fielding, 2001; 2012; Lodge, 2005; Mitra, 2006; Ontario Ministry of Education, 2013; Toshalis & Nakkula 2012) developed various typologies to describe student voice. In 2013, the Ontario Ministry of Education's Literacy and Numeracy Secretariat published a building capacity monograph titled "*Student Voice*". This monograph included a student voice continuum (Figure 1) that was used as a reflective tool for the survey.

Figure 1: Student Voice Continuum (LNS, September 2013)

The last exercise during the reflection day, involved administrators, teachers and students indicating where they saw themselves on the continuum during the process of SCLC or SLLW (Figure 2) and during the reflection meeting (Figure 3). It is important to note that students identified their participation in both activities further along the continuum than their teachers and principals. All stakeholders identified their participation further along the continuum during the reflection day.

FOCUS GROUP INTERVIEWS

Educators from four schools were invited to engage in a conversation around the impact, success, and challenges of participating in the SCLC and SLLW process. In addition, educators were asked to share their recommendations for future visits within our board.

Emergent themes from the analysis of the focus group interview were based on highest frequency of occurrence of ideas and opinions. These themes were: SIPSA monitoring, student voice, transformative practice, administrator as learner, recruitment, and empowerment.

STUDENT VOICE

Educators noticed that students use the language of instruction such as "number talks" and "spatializing fractions".

"I thought it was exciting when the kids were coming to the meetings to see how the kids internalized how we speak. When they spoke using terms like, spatializing fractions or how they talk about SIPSA or the keys to success."

In many instances students voiced the importance of the resources/tools that supported them in their math learning and made suggestions for teacher practice.

"Students made the suggestion of moving the manipulatives to the front of the room because they were easily accessible."

"Everyday is new learning for me and it teaches kids to reflect on how they learn. It has totally changed my classroom. I love how they are advocating for themselves. I had not seen that in the past, and now all of a sudden they were asking for things and normally they would just wait until I gave it to them. Now I have more leaders in the class."

SIPSA MONITORING

The process allowed for a focused and authentic monitoring of the SIPSA. Educators indicated that SIPSA goals were evident during the walk, and they noticed their SIPSA goals and strategies throughout the school. The SIPSA was now a living document within the school community. The students in the schools were able to articulate the goals of the SIPSA. Some schools have plans to include SCLC and SLLW in their SIPSA as a way to monitor their goals. The teachers and administrators expressed:

"We're seeing the kids take ownership of it (SIPSA). They really feel like they have a voice and the confidence that comes from that. The kids are clearly articulating what their learning and being able to articulate the SIPSA as well."

EMPOWERING TRANSFORMATIVE PRACTICE

The process was transformative to administrators, educators, and students. A pivotal transformation for administrators and educators was listening to student voice, as this process used student voice in the monitoring of school improvement efforts. Since teacher actions were showing up in the kids' voices, teachers were more aware of their impact in the

Figure 2: SCLC or SLLW Voice Continuum

Figure 3: Reflection Day Voice Continuum

MATH TASK FORCE 2.0

"I never thought I'd be that kind of a person who would say, come on in, come on in or why aren't you coming in. I never thought I'd be like that."

"My next step is going to be to continue to learn and continue to keep this going. The last time we had the SLLW, I wasn't a part of it because I had to share, I had to let somebody else in on it, I want to know, how can I get back in on this because I find it so valuable."

classroom and the connection between teaching and learning. This was how the classroom became student led.

"Even just the impact to see the students interacting and to see how proud they were to be leaders like every room you went into they felt proud. They invited us to see them since they really felt it is important."

"One of the student that I selected was a student with special needs who had a hard time communicating but was fully engaged in number talks and experienced success."

An administrator added:

"I feel more empowered as an administrator. I find going into classrooms and talking to educators and students about learning is transformational. I feel more confident in my own practice."

Teachers expressed their interest in collaborating with others after being engaged in the SCLC and SLLW. They opened their doors to allow colleagues to observe their classrooms. Since this process was non- evaluative, the teachers welcomed the idea of visits and want to engage again in this process.

"I never thought I'd be that kind of a person who would say, come on in, come on in, or why aren't you coming in. I never thought I'd be like that."

"Staff is getting so excited and wanting to be a part of it and then everyone is just opening their doors to each other, it has changed the dynamics of that in our school and all because of kids voices, all because of them really."

According to educators, the students who were the lead walkers and were part of the student debrief looked more confident in the way they carried themselves after the visit. The teachers were able to see beyond the well-being.

"He was standing differently, like he was carrying himself differently, standing differently holding himself differently."

"You could see a physical transformation in that child he wasn't as tentative, he was maintaining eye contact he was smiling, he was feeling empowered."

Administrator as Learner

As administrators were afforded the time to be at the meeting and observing classrooms for a whole day. Principals expressed the importance of the presence of the administrators at the table as a learner. The following are excerpts from administrators:

"It afforded me time dedicated to observing students and listening to student voice as it relates to learning."

"The importance of the administrator being at the table and being part of the process, not only as a learner, but to support the staff going forward. It's trust and support. It's important to be part of the positive feedback as well, to confirm that hard work is paying off."

Recruitment

Administrators and educators discussed how recruitment for the first visit was a challenge. Once the visit was completed, it created a buzz in the building where more educators were interested in participating. This was evident in the second visit where recruitment of teachers was not an issue and almost 100% volunteered at two thirds of the participating schools. It was recommended that a past participating principal and a teacher visit new schools to explain the process and clarify any questions.

DISCUSSION

It is the first time in our board history where students come together with educators, administrators and senior administration to engage in conversation about the pedagogy of teaching and learning. What students say about teaching and learning provides an important foundation for thinking about ways of improving schools (Lodge, 2005). The data from the SCLC and SLLW visits showed strong evidence of the impact of student voice on transforming teacher

practice and administrators' situational leadership. The teachers highlighted that listening to student voice has shifted their practice in the classroom to make the learning process more inclusive. As a result of the student participation in conversations about school improvement, we have noticed that students were able to articulate the components of their SIPSA, and make suggestions and take actions regarding teaching and learning. After students' involvement in the processes of SCLC and SLLW, some schools have cofounded students' focus groups and student councils to continue their partnerships. This grassroots approach to leadership amongst our young students is strongly supported by the literature (Mitra, 2008; Lodge 2008; Ritchhart, 2015).

Mitra (2008, p.25) indicates, "participating in reform efforts increases student's agency, self-worth, respect and a sense of membership in school. To become effective leaders, youth need to participate deeply not simply be heard." An educator summarized the need for student active involvement by stating: "Because they have a voice and they know now. Before we didn't tell them that we are working on, we just took it on ourselves. What are we going to do? What strategy are we going to put in place? But we didn't tell them. Now they know what struggles we have at school, and collectively we are working on school improvement. And you never thought before to let them know. You just thought, oh we have a problem; we just tried to fix it on our own."

As part of the process , choosing colleagues to be partners in the visits has allowed teachers to feel comfortable in opening their classrooms for observations. This collaboration turned into an empowering safe environment where teachers were left with aspirations to collaborate in their teaching career. As both processes focused on student voice and the physical environment, the educators saw the benefit in establishing a culture that nurtures a collegial exchange of ideas and promotes a certain level of trust between educators and students. We agree that opportunities for including student voice are limitless and there is no single approach to classroom observation, but when expectations are clear and participants understand how to use and benefit from the process, the impact is more profound. The importance of creating safe spaces for educators and students to work together forms a reciprocal engagement where both teach one another (Fielding, June, 2001, 2004, 2012; Levin, 2000; Lodge, 2008; Mitra, 2006).

Educators realized the importance of giving feedback to students who participated in these processes about what change was made due to their involvement. As mentioned by educators; "I think the next step is following up with students if you are going to use them to provide information, then there has to be some kind of follow up with them as well. They would like to know how you have implemented what they have told you or have used their voice. Do you value their voice or not?" This was supported by Fitzgerald et al. (2010) who argues that when students are involved in participatory opportunities with teachers, they need to receive a great amount of feedback regarding the value of their contribution and what evidence of decisions were taken based on their voice.

At the GECDSB, students have the competency to engage in mathematics pedagogical discourse. The reason for including student voice was not only to be part of the conversations, but also to ensure that educators accurately interpret the information given to us by students (Mitra, 2008). Throughout this process, we witnessed students of all ages engaging in mathematics teaching and learning. Our district finally found a niche where "staff and students meet one another as equals, as genuine partners in the shared understanding of making meaning to their work together" (Fielding, 2004, p.309). At the GECDSB, we believe that SCLC and SLLW provide the structures and the conditions needed to make student voice in the school improvement process a lived reality. The conditions allowed for teachers to see their voice reflected in their students who were re-positioned as agents of positive educational change.

"Change is a big idea. To genuinely engage not only students' voices but also their entire beings, we need to be open to change, willing to change."
(Cook-Sather, 2006, p.383)

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LINKS

Student Voice
http://www.edu.gov.on.ca/eng/literacynumeracy/inspire/research/ CBS_StudentVoice.pdf

Supporting All Mathematics Learners through Responsive Learning Environments
https://www.publicboard.ca/Board/Administrative-Reports/Math-Task-Force/ Documents/Supporting%20All%20Mathematics%20Learners%20through%20Responsive%20Learning%20Environments%20.pdf

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