Measuring the Impact of the Math Focus Project 2015-2019

September 2019

in collaboration with

MaST Math and Science DEEN Sub-Committee

Introduction

What is the Math Focus Project?

Formerly referred to as the Math Summer Institute (MSI) or the Elementary Math Focus Project (EMF), the **Math Focus Project** started in August 2015 as a *pilot project* 3-day residential professional development program involving the highly respected math animators: Julie Dixon, Edward Nolan, Thomasenia Adams (DNA) team from the United States. At the end of the three days, it was evident from the feedback from both the teacher participants and the School Board Consultants that this Professional Development project was ground-breaking and meeting a much-desired need to shift mathematics pedagogy in our Provincial community of English-speaking Quebec.

The project was then extended, and participants were organized into Cohorts. Each Cohort received a three-day residential PD in St. Sauveur, during the month of August over a three-year commitment period. During this time, not only did the teachers attend the conference annually, but to expand the reach, each School Board/Association offered local implementation of the project by their Math Consultant(s). These initiatives were supported by the LCEEQ and DEEN MaST Committee to attendees and non-attendees. Cohort 2 started in August 2016, Cohort 3 in August 2017, Cohort 4 in 2018 with Cohort 5 starting in August 2019.

Since its inception, over 671 teachers has received the PD directly and hundreds more have been impacted indirectly, including, but certainly not limited to: consultants, principals, and of course, students.

Table 1: Participation Attrition Rates

number of teachers	2016	2017	2018	2019	Attrition %
Cohort 1	**79**	**65**			82
Cohort 2	**151**	**144**	**122**		81
Cohort 3		**135**	**118**	**105**	78
Cohort 4			**119**	**106**	89
Cohort 5				**115**	-
Overall	**230**	**344**	**359**	**326**	**82**

As shown in Table 1, over the course of the three-year commitment, 82% of teachers who started have completed the training to date.

What Change in Math Pedagogy Does the Math Focus Project Create?

In 2014 the *National Council of Teachers in Mathematics* (NCTM) published the article *Principles to Action: Ensuring Mathematical Success for All.* This document outlines the shifts in mathematics pedagogy required to offer effective mathematics learning for all. They suggest that:

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. (NCTM, 2014, p.7)

This is a change from the traditional mathematics classroom of individual seatwork and teacher worked examples. In addition, Kilpatrick et al (2001) have defined mathematical proficiency as what it means for anyone to learn mathematics successfully. Mathematical proficiency, as they see it, has five strands:

1. **Conceptual Understanding** - the connection of concepts, operations and relations
2. **Procedural Fluency -** meaningful and flexible use of procedures to solve problems
3. **Strategic Compliance -** ability to formulate, represent and solve math problems
4. **Adaptive Reasoning -** capacity to think logically and justify one's thinking
5. **Productive Disposition –** the attitude and desire to persevere in solving problems

(Kilpatrick et al, 2001, p.5)

Therefore, for our students to be mathematically proficient, our teachers must shift the way mathematics is taught and learned in the classroom by focusing primarily on the students' abilities with these five interrelated strands.

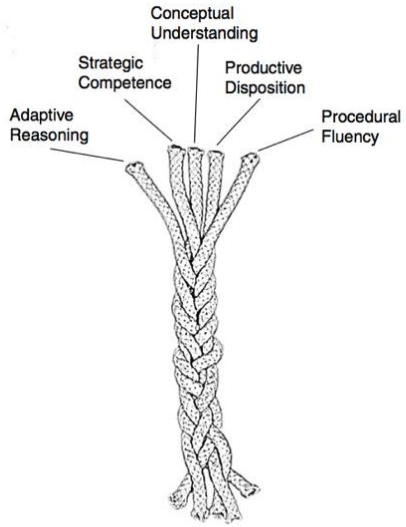


Figure 1: Mathematical Proficiency Strands

To specifically adopt the five interrelated strands, teachers must shift their practice. They not only require a new set of skills, but a change in their own beliefs about mathematics education. To be more specific, the teachers focus on eight teaching practices which align to the strands.

8 Mathematical  Teaching Practices

1. 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.

2. 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 strategies.

3. 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.

4. 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.

5. 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.

6. 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.

7. Support productive struggle in learning mathematics.

Effective teaching of mathematics consistently provides students, individually and collectively, with opportunities and support to engage in productive struggle as they grapple with mathematical ideas and relationships.

8. Elicit and use evidence of student thinking.

Effective teaching of mathematics uses evidence of student thinking to assess progress toward understanding and to adjust instruction continually in ways that support and extend learning.

How Can We Demonstrate the Effectiveness of Professional Development Programs Such as the Math Focus Project?

In this report, we will be using Guskey's (2002) five critical levels[1] as evidence of the impact this project has had on our stakeholders (students, teachers, principals, consultants, and community).

The table in **Appendix A** briefly describes the questions addressed at each level, how the information should be gathered, what is measured/assessed, and how the information should be used. The use of these 5 levels demonstrates a holistic view of the professional development. It begins at level 1, which describes how the participants perceive the professional development and moves all the way up to level 5, which describes student learning outcomes.

Level 1: Participant Reactions
Level 2: Participant Learnings
Level 3: Organization's Support and Change
Level 4: Participant Use of New Knowledge, Skill and Attitude
Level 5: Student Learning Outcomes

[1] The five levels are hierarchical, with each succeeding level building on the one before.

Level 1: Participants' Reactions

The first, simplest, and most common evaluation of professional development experiences is the participants' reactions to the experience. Although these measures are often perceived as not having much worth, measuring participants' initial satisfaction with the experience provides information that can help improve the design and delivery of programs or activities in valid and meaningful ways (Guskey, 2002).

In August 2015, a twenty-five question feedback form was sent to the participants of the initial pilot group. When it was decided that the project would continue as a three-year institute, LCEEQ hired a consulting firm to do an impact study prior to August 2016. Unfortunately, the project's steering committee, as well as the LCEEQ's Professional Development Sub-Committee (PDSC), were unimpressed with the firm's professionalism and communication skills and it was decided to sever ties with the consulting firm. The firm maintains that all August 2016 data was their intellectual property making it unavailable for the purposes of this or any future reports. This report, therefore, will focus on the feedback provided from August 2017 and August 2018.

The August 2017 and August 2018 surveys each had 25 questions that included everything from the location, our communication, their practice and dispositions in mathematics, the facilitators (both the outside consultants and the school board consultants), the content and their perceived needs in follow-up professional development. Given the generally unchanging, positive feedback on the location and the committee's clarity of communication, this information will not be included in this report, however it can be produced upon request. The sub-committee has, over the past five years, had to address issues related to the pacing and content of the sessions. Below are the graphs that show the participants' change in responses due to our action on these areas. Given the cost associated with bringing in outside consultants, the subcommittee felt it was important

to also include in this report the data that shows that participants consistently rate these presenters highly. The table below shows the number of participants and response rate, per Cohort, for the August 2017 and August 2018 surveys.

Table 2: Number of Participants and Response Rates for August 2017 and August 2018

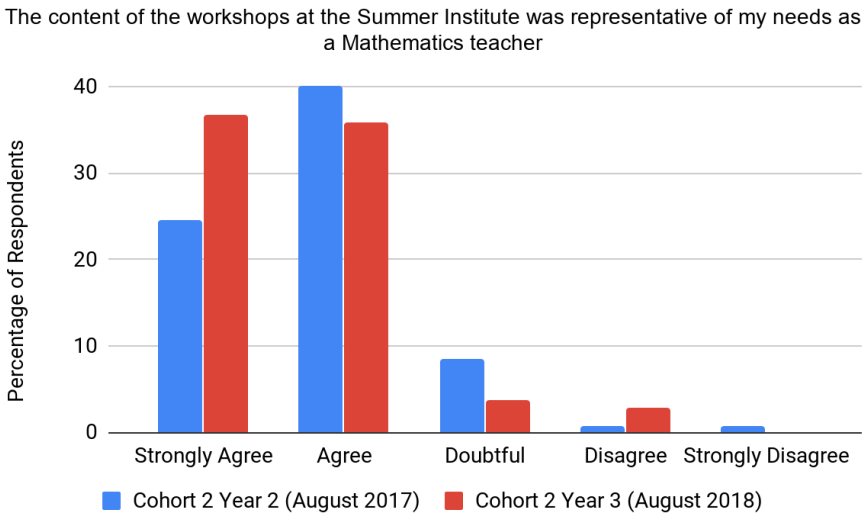
	Cohort 2	Cohort 3	Cohort 4
August 2017	n = 130 Response rate: 74.62%	n = 121 Response rate: 81.82%	N/A
August 2018	n = 106 Response rate: 79.25%	n = 102 Response rate: 87.25%	n = 103 Response rate: 77.67%

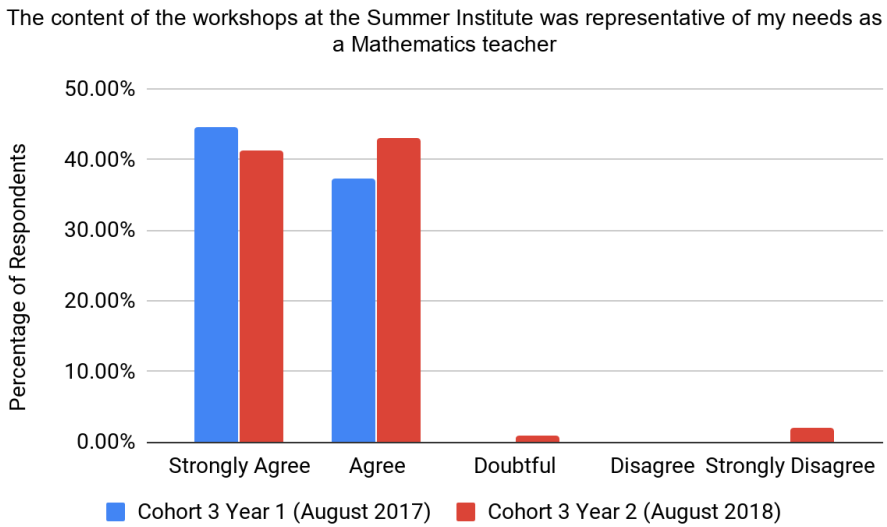
Content of Workshop Sessions

When responding to the question “The content of the workshops at the Summer Institute was representative of my needs as a Mathematics teacher”, the participants’ answers were positive overall (see Figure 2). These results indicate that the content was appropriately selected and responded to participant expectations. Only a very small number of participants indicated some level of dissatisfaction. Nonetheless, to increase participant satisfaction, an analysis and review of the content was consistently made.

In August 2016, the steering committee opened the registration up for Cycle 1 high school teachers with the understanding that they would be joining the program from more of a *Response to Intervention* perspective. That year, the DNA team offered a 6-8 grade band based on content in the Common Core State Standards (CCSS) which is the content progression per grade level in the United States.

Figure 2: Teacher's Perception of the Content Learned at the Institute, Cohorts 2 and 3





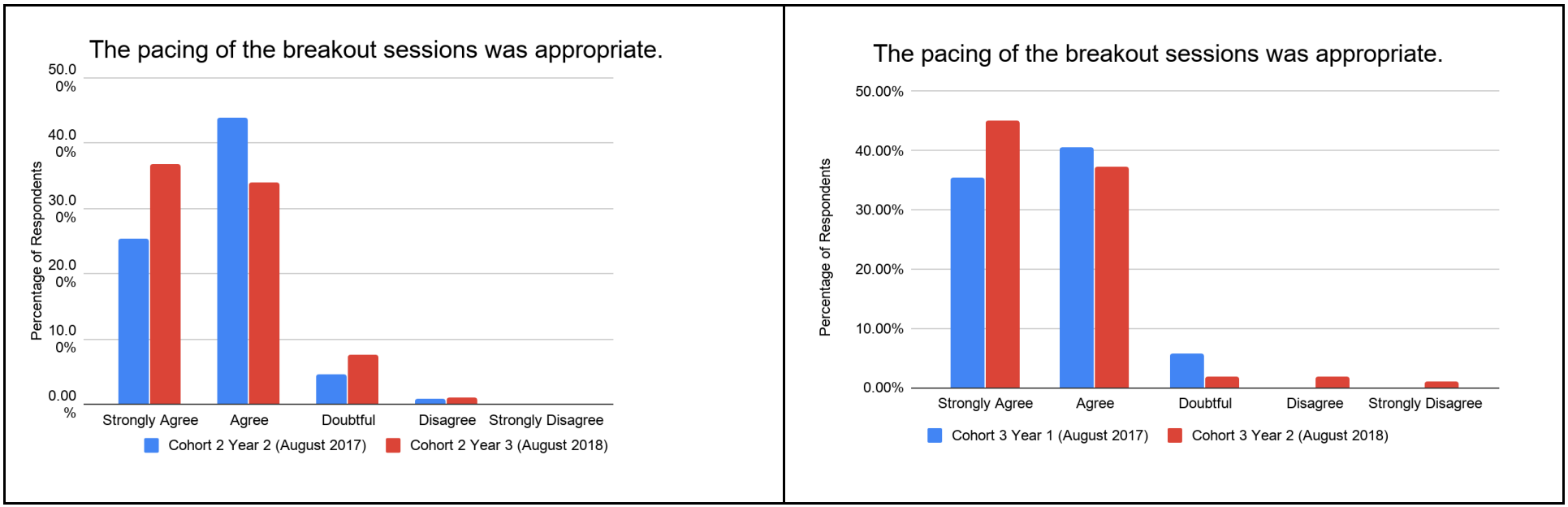
What we discovered is that the content was largely high school and did not serve our Grade 6 teachers well. In addition, the steering committee noticed that when considering the content standards in the Québec Education Program and the data the English Community collected from the Grade 6 Compulsory Exam, some tweaking of the content was needed. Between August 2016 and August 2017, designated members of the steering committee worked with the DNA team to improve the workshop content to meet our needs. The DNA was responsive and developed new materials on decimal numbers to meet our request. As we can see in Figure 2, most participants feel that the content of the workshops is representative of their needs as Mathematics teachers. When mining for the why behind the "disagree" in Cohort 2 Year 3, we find that it is a Cycle 2 High School teacher (grades 9-11) who is unhappy that the content in the 5-7 grade band does not address their teaching load. The "strongly disagree" in Cohort 3 Year 2 is also interesting as it is a K-2 teacher that believes that the content (linear measurement) is easy to teach and would

have preferred different content. When looking at the Grade 6 results, however, we see that students struggle with the difference between linear measurements, perimeter and area.

Pacing of Workshop Sessions

When responding to the question “The pacing of the breakout sessions was appropriate”, the participants’ answers were also very positive overall (see figure 2).. Only a very small number of participants indicated some level of dissatisfaction. Nonetheless, to increase participant satisfaction, an analysis and review of the pacing of the breakout sessions was consistently made.

Figure 3: Teacher’s Perception of the Pacing of the Workshop, Cohort 2 and 3



When considering the pacing of the workshops, the “doubtfuls” and the “disagrees” in both Cohort 2 and Cohort 3, they mostly have to do with the pace being too slow. The justification that accompanies those ratings follows two general themes:

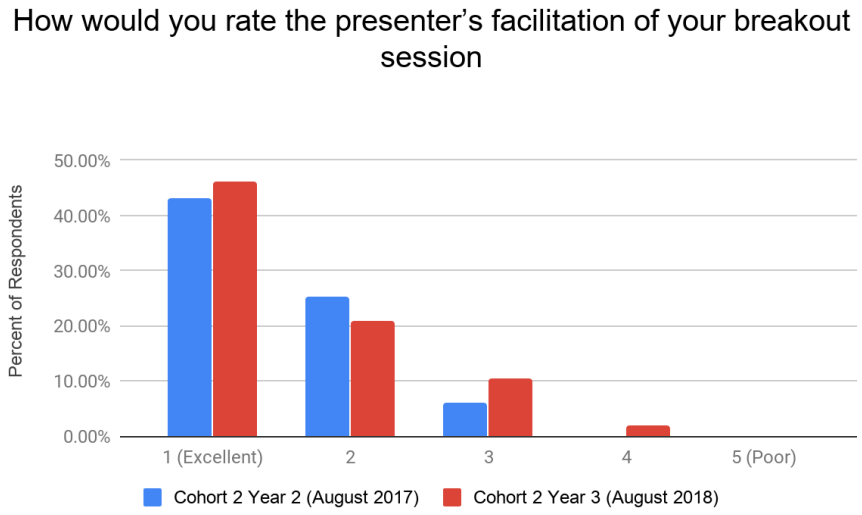
- The participants did not enjoy being positioned as students since they felt that they could have seen more content instead
- The DNA team did not get through all the handouts and therefore the participants felt they missed out

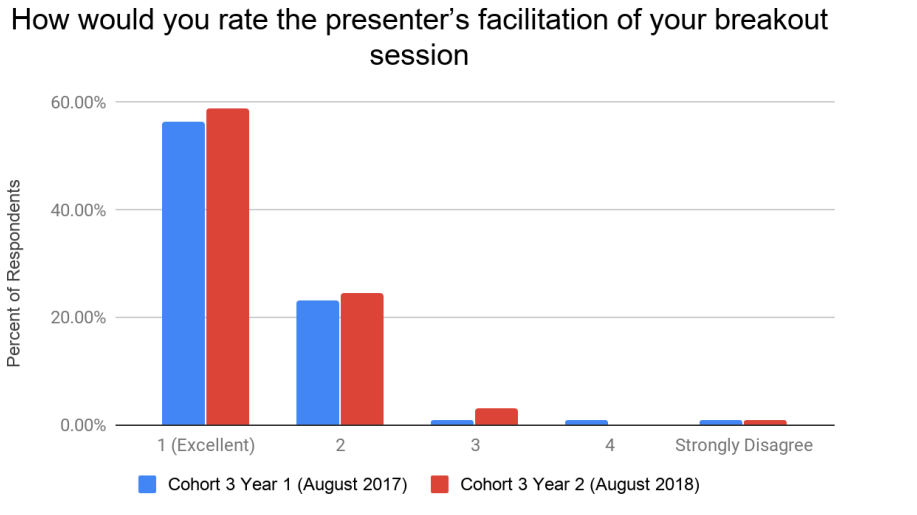
There are specific pedagogical reasons the DNA team positions the teachers as learners, one of them being that this positioning allows teachers to feel the discomfort of *not knowing*; they are challenged on their conceptual understanding of the content and the DNA facilitator is modelling the pedagogical practices we want the teachers to replicate in their own classrooms. To address the second issue, in August 2018, we started packaging the handouts separately (per day/session). This way, the DNA team was better able to coordinate their pacing among themselves to meet the needs of the groups without any pressure to “get through” the material, abiding by the philosophy of *less is more*.

DNA Mathematics Team

In the pilot year, a core group of four facilitators - Juli Dixon, Ed Nolan, Thomasenia Lott Adams and George Roy - each facilitated a breakout session. In the second year a fifth member, Farshid Safi, was added to our facilitator team. When we introduced Cohort 3 and Cohort 4, the team grew to nine members including: Lisa Brooks, Tashana Howse, Melissa Carli, Brian Dean, and Jennifer Tobias. Figure 4 shows the participants’ ratings of the DNA team members’ facilitations where the descriptor for “1” is “excellent” and the descriptor for “5” is “poor”. The majority of participants responded with a level 1 or 2 and therefore indicated an appreciation of the quality of the presenters’ facilitation (see figure 4).

Figure 4: Teacher's Quality Rating of the DNA Facilitators, Cohort 2 and 3 (1=Excellent and 5=Poor/Strongly Disagree)





The steering committee feels that these results support the choice of facilitators. As the DNA team grew bigger, we did see a few more "3", "4" and "5" ratings. Most of the "3s" and "4s" in Cohort 2 Year 3 are related to a particular facilitator who was tasked with replacing a very beloved facilitator, as the latter had a family emergency; thus the replacement facilitator was being compared to the former, who had spent two summers with the group already. As for the "3s", "4s" and "5s" in Cohort 3, they relate mostly to a facilitator who was newer in the role and had a particularly challenging group of teachers. That case was discussed with Dr. Dixon, Mr. Nolan and Dr. Adams.

Level 2: Participants' Learning

This level focuses on measuring the participants' acquisition of knowledge, skills and attitudes. In order to analyze the potential shift in participants' knowledge, skills and/or attitudes, we will look at longitudinal data collected prior to the professional development experience, as well as after each summer session.

In terms of knowledge acquired, the content for each grade band was specifically designed to align with the *Quebec Education Program* (QEP) and the progressions of learning. The DNA team had to consider which tasks and content to cover so that the teachers would get the most benefit from the sessions. An example of the content over the 3 years of the project is shown in Table 3 below.

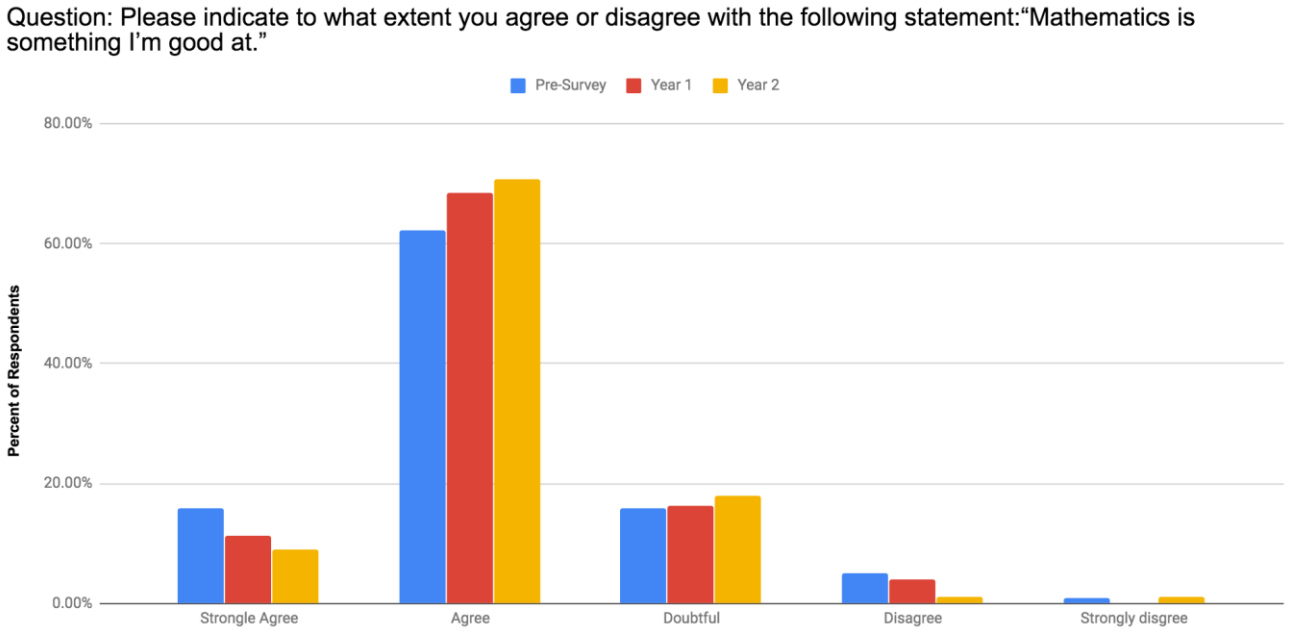
Table 3: Grade Band Sessions & Content Example, Kindergarten to Grade 2, Over a Three-Year Period

	Year 1	**Year 2**	**Year 3**
K-2	● Early number ● Word problems ● Place value ● Addition and subtraction ● Geometry	● Measurement: ○ Constructing rulers/broken-ruler activities ○ Conceptualizing lengths (with unconventional units) ○ Conceptualizing lengths (with conventional units: m, dm, cm.) ● Geometry: ○ Plane figures: Identifies and describes squares, rectangles, triangles, rhombuses and circles) ○ Problem Solving	● Fractions: ○ 1/2, 1/3, and 1/4 ○ Identifies fractions to everyday items ○ Represents fractions in a variety of ways (whole, collections): ● Developing the meaning of the equal sign (relational thinking vs operator) ● Determines the missing term ● Composes/Decomposes #s in a variety of ways, equivalent expressions ● Describes number patterns

Refer to Appendix for other Grade 3-4, Grade 5-7 and Grade 8-9 band content.

With respect to attitudes towards teaching mathematics, we collected a pre-survey data as well as two years of post-survey data[2] for Cohort 3. This data allows us to look for shifts in participants' attitudes with respect to their comfort and their practice in teaching mathematics. In each graph, the blue bar represents the pre-survey responses (n = 120), the red bar represents the responses at the end of their first summer (n = 99), and the yellow bar represents the responses after the participants' second summer (n =89).

Figure 5: Cohort 3 Response to "Mathematics is Something I'm Good At", over a three year period



[2] As Cohort 1 was a pilot summer pre-survey data was not collected. Pre-survey data was collected in Year 2 but is not in the possession of LCEEQ.

Figure 6: Cohort 4 Response to "Mathematics is Something I'm Good At" over a two year period

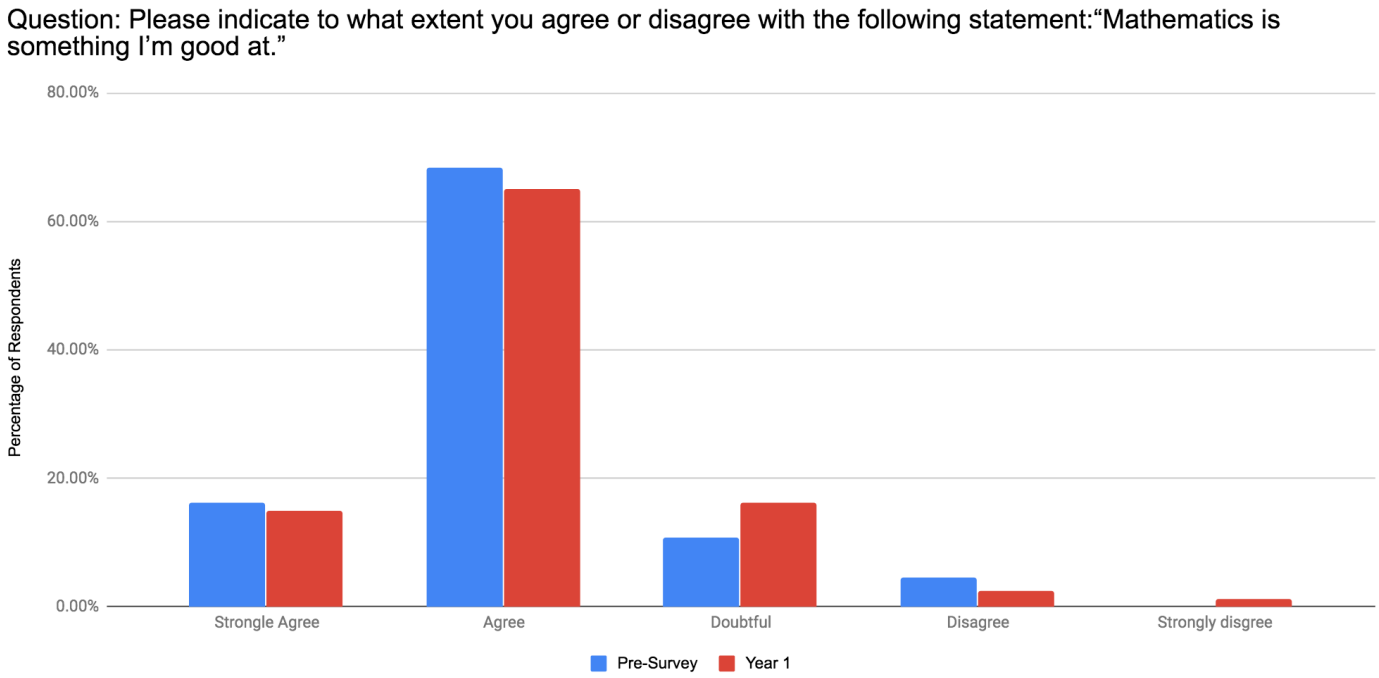


Figure 6 shows a shift away from "Disagree" disposition to a majority "Agree" position. The lowering from teachers from the "Strongly Agree" position could be a result of increased knowledge about mathematics, and the humbling effect of knowing that now there is so much more to learn. It can be a challenge to separate a participant's learning (level 2) from their application of their learning in practice (level 4).

Level 3: Organization Support and Change

At this level the focus shifts to organizational support and change. According to Guskey (2002), organizational variables can be the key to the success of any professional development effort. The difficulty in analyzing this project from the *Organizational Support and Change* perspective is that in this case the organization, LCEEQ, is a collective whose members hail from ten different public-School Boards and two Associations representing private schools. This demographic encompasses the vast majority of English-speaking students across the province of Quebec. The role of the LCEEQ is not to dictate professional development policy, but to support the various initiatives taken within each of the organizations.

Given local autonomy and the intensity of the proposed project, in November 2015, Boards/Associations were invited to participate in a pilot project planned for August 2015. The option to participate included an obligation to commit to the participation of the mathematics consultant(s) and a minimum of two professional development days of ongoing training for teacher participants in the Math Focus Project in order to ensure ongoing development of the concepts and strategies throughout the academic year that were introduced in the summer.

Given the important role that principals play in supporting pedagogical development within the school, as part of the initial recruiting process for the first Cohort of teachers, in December 2015, principals were invited to a half-day workshop presented by Dr. Juli Dixon to gain a better understanding of the underpinnings of the project so that they would be in a better position to encourage their teachers to participate in the pilot project.

Having access to Dr. Dixon in Montreal, the second half of the day saw a session for the math consultants who would be helping recruit teachers, but more importantly, supporting them in their learning during the summer workshops and then in their classrooms in the months and years to come.

Once the pilot project was deemed successful and the decision was made to offer a three-year training cycle for participating teachers, the School Boards/Associations were expected to submit a three-year plan for implementation, describing the means of supporting the Math Focus Project participants, and a plan for how the concepts and strategies would be introduced to all mathematics teachers across the organization in a systemic fashion. At the end of each year they were requested to submit a progress report and any alterations to the plan moving forward.

It is important to reiterate that each School Board/Association has the latitude to implement the project based on local needs and conditions and so assumes the responsibility for meeting the initial commitment for participation. LCEEQ is not mandated to evaluate the various organizations but to provide professional development support where possible. An example of such was a workshop offered to Mathematics Consultants in May of 2019 entitled: ***Supporting the Math Focus Project through Enhanced Coaching Skills*** presented by Sara Frisbie on behalf of NCSM.

It must be stated that since the onset of the project, there have been several changes within the ranks of the mathematics consultants. This certainly has impacted on the continuity that any one Board/Association has been able to maintain throughout. It must be further stated, however, that those individuals who have joined the process either on a full-time or part-time basis have fully engaged in supporting the process.

The original proposal was for three Cohorts of elementary school teachers over a five-year cycle. The success of the project and the enthusiasm created within the system has resulted in extending the project to five Cohorts of teachers, including a dedicated Grade 8-9 group in the last two Cohorts.

Level 4: Participants' Use of New Knowledge and Skill

At this Level, we are looking to establish to what extent the new knowledge and skills learned is making a difference in the teachers' professional practice. According to Guskey (2016), participants need sufficient time to reflect on what they have learned, therefore it is recommended to gather measures of use at several points. The *Self-Evaluation Hexagon Survey (Appendix)* has proven useful in illustrating the teachers' perceived progress over time. Teachers were asked to indicate the respective levels at which they were prior to the LCEEQ PD. They were then invited to indicate where they saw themselves at that particular point in time and where they would like to be. Several months later, they once again reflected on their practice to determine which of the goals they achieved and where they would like to focus their efforts moving forward. Overall, the feedback clearly demonstrates that teachers have been able to implement new strategies in all five mathematical areas of classroom discourse.

An *Anecdotal Survey: PLC & Mathematics (see PDF)* was used in one school to pinpoint specific improvements and gather anecdotal comments. Though ⅔ of the staff have not attended the EMF, all 15 teachers who completed the survey expressed positive impacts as a result of the math focus that has taken place in their school. More than half the teachers indicated that they have implemented Math Talks in their classroom and many stated an increase in the use of manipulatives and games. Moreover, the survey reveals that students and teachers alike are changing how they speak about math: teachers are asking more open questions to guide thinking and students are discussing their thinking with their peers.

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Figure 7: Teacher Perception of Using Student Invented Strategies over Time

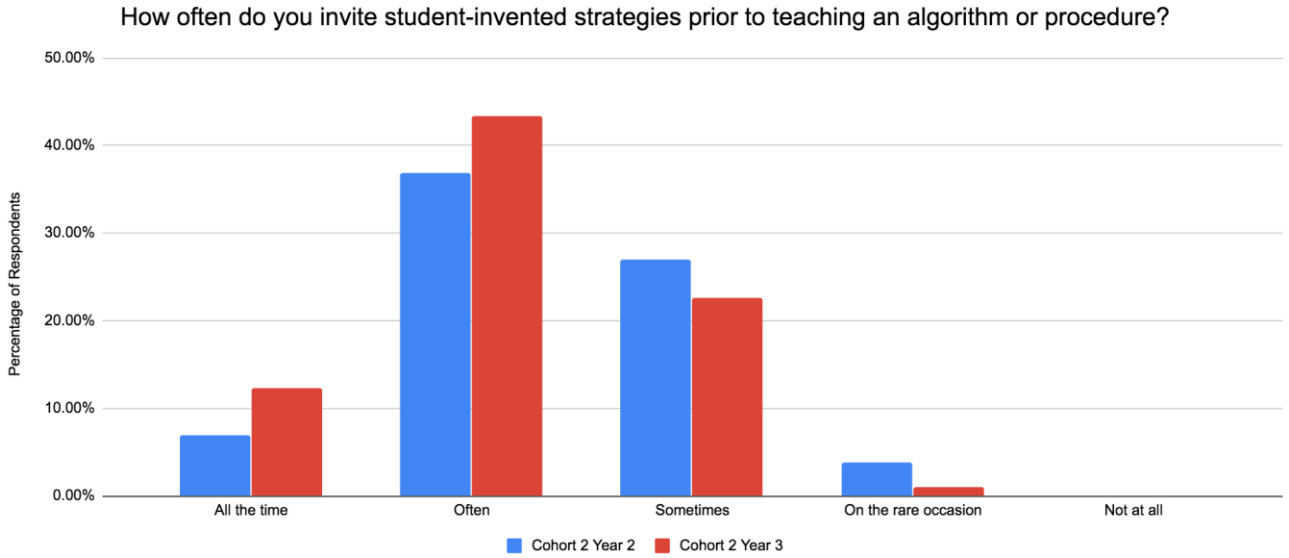
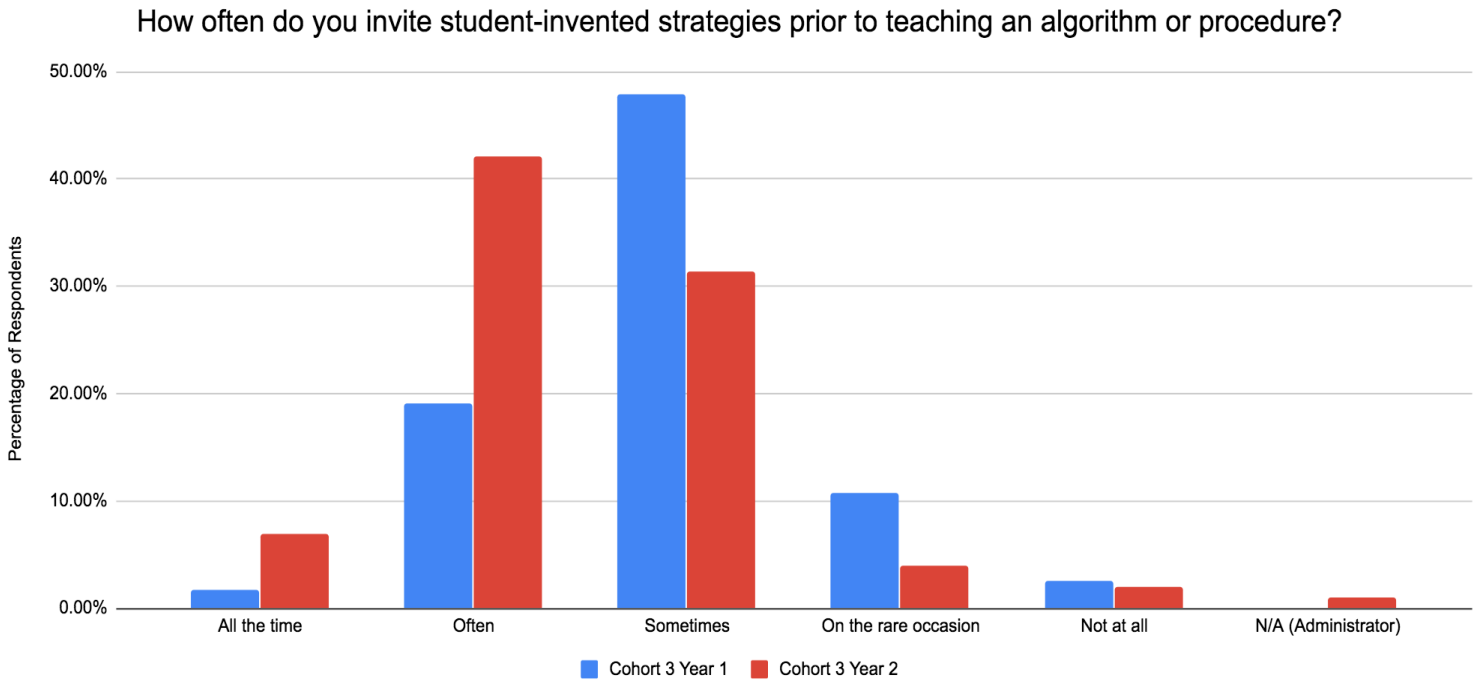


Figure 8: Teacher Perception of How often they Use Student Invented Strategies to Teach Algorithms or Procedures



The data shown above shows a significant change in teacher perception of how and when to use student invented strategies to teach procedures. The largest shift observed is the jump in teacher reporting of “sometimes”; initially it was at 48%, but it later shifted to 30%. This shift is due to more teachers reporting that they now “often” use this strategy: 19% before, and 41% afterwards. There was also in increase in teachers reporting they always do this, going from 1% to 7%.

Figure 9: Teacher Perception of How often they Use Manipulatives in the Classroom Cohort 2

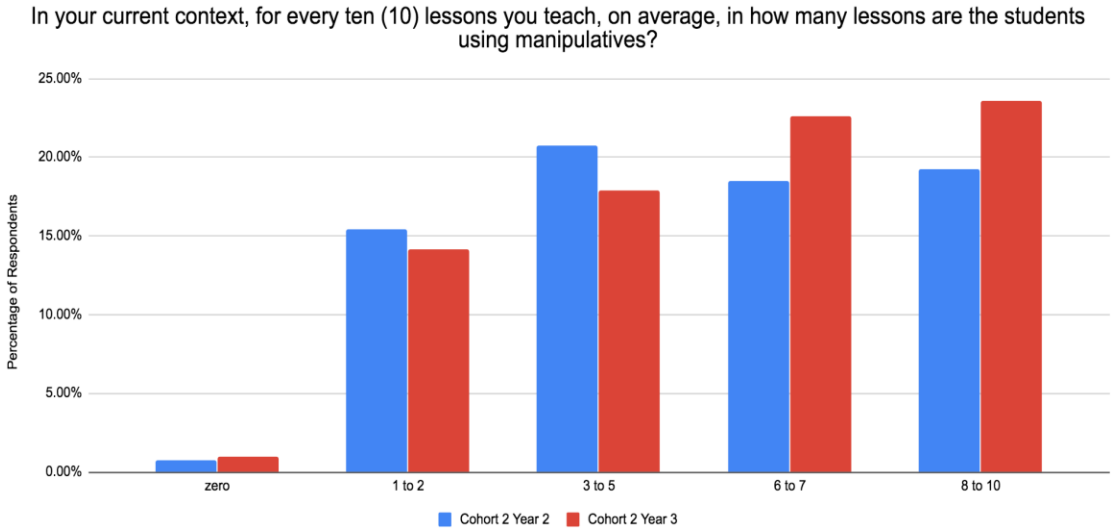
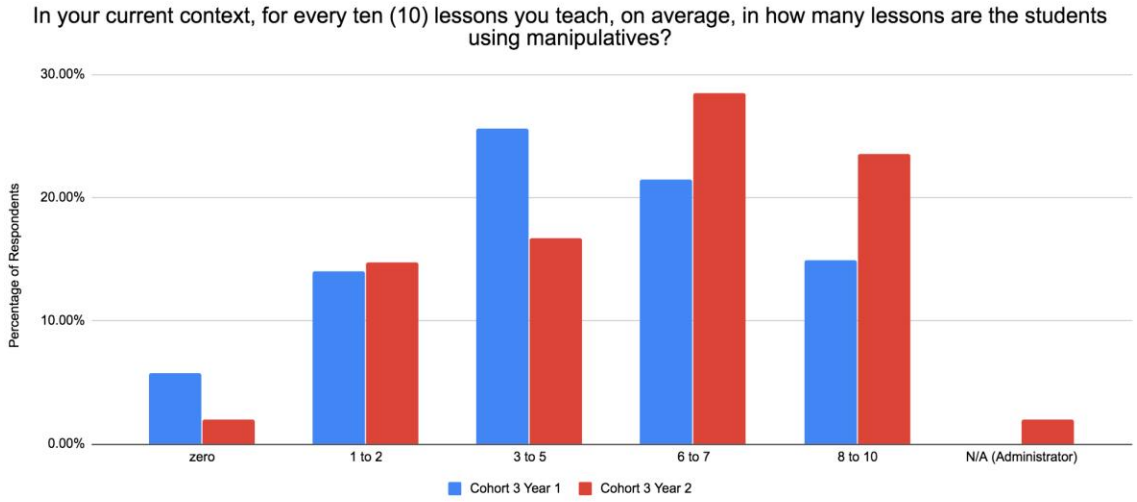
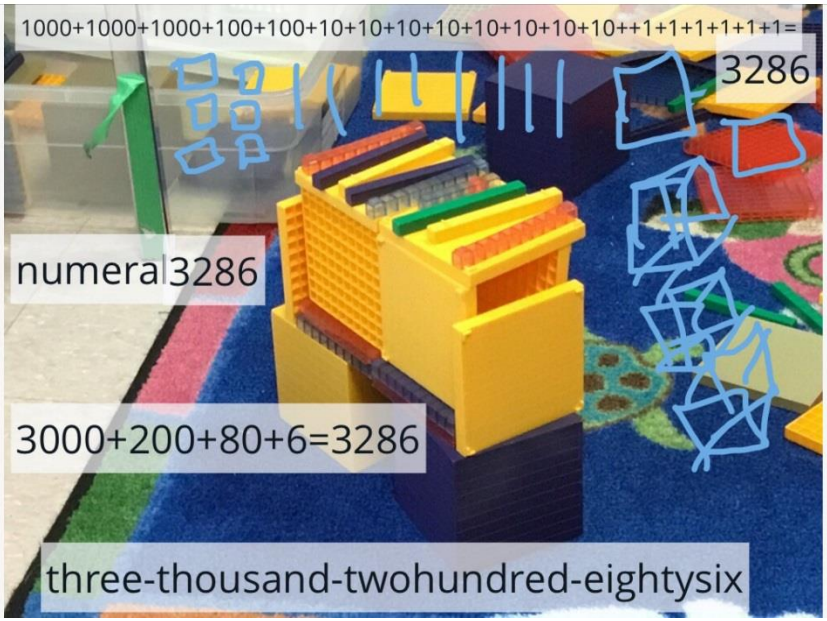


Figure 10: Teacher Perception of How often they Use Manipulatives in the Classroom Cohort 3





The use of manipulatives in the classroom promotes mathematical practices 2, 3, 4 and 8 (US version of QEP Competencies, see NCTM, 2014) and therefore if there is an increase in teachers using manipulatives in the classroom there is likely a shift towards the improved mathematical practices the Math Focus Project is promoting. As shown in Figure 9 and 10 above, there is clearly a shift towards an increased frequency in the use of teachers reporting the use of manipulatives in their classrooms after a one year period reported by both Cohort 2 and 3.

As mentioned in Level 3, math consultants recently attended a workshop entitled ***Supporting the Math Focus Project through Enhanced Coaching Skills***. The workshop provided the consultants with the opportunity to reflect on their practice and to consider new avenues to explore. As a result, a new element has been designed and added to the pre and post-survey for the Math Focus Project, replacing some questions that were similar in nature. Inspired by the work of Maggie B. McGatha & Jennifer M. Bay-Williams (2018) in their educational publication entitled ***Everything You Need for Mathematics Coaching***, the *Desire Teaching Practices Survey* questionnaire below will permit teachers to indicate where they situate themselves and their students in their current practice of mathematics teaching. Moreover, consultants will be able to more easily and readily interpret the data. The nature of the information gathered by this questionnaire will shed light on the teachers' perceived starting point, especially in relation to their skills, and it will allow us to establish progress over time. Moreover, it will be another indicator used to measure the impact of this professional development.

Table 4: Desired Mathematical Teaching Practices Survey

Check the box that reflects the frequency with which you use the following teaching practices:

Classroom Practice	Frequency			
	Consistently	Often	Sometimes	Rarely
Communicating Expectations for Learning				
I create lesson-specific learning goals	❒	❒	❒	❒
I communicate these goals at critical times within the lesson	❒	❒	❒	❒
My students understand the lesson's purpose	❒	❒	❒	❒
Using Tasks That Promote Reasoning				
I use tasks that lend themselves to multiple representations (e.g. physical, symbolic, visual, contextual, or verbal), strategies or pathways	❒	❒	❒	❒
I use tasks that encourage student explanation and justification of student thinking	❒	❒	❒	❒
I provide opportunities for students to compare different representations	❒	❒	❒	❒
Orchestrating Mathematical Discussions				
My students share, listen and critique each other's ideas to clarify and deepen mathematical understanding and language	❒	❒	❒	❒

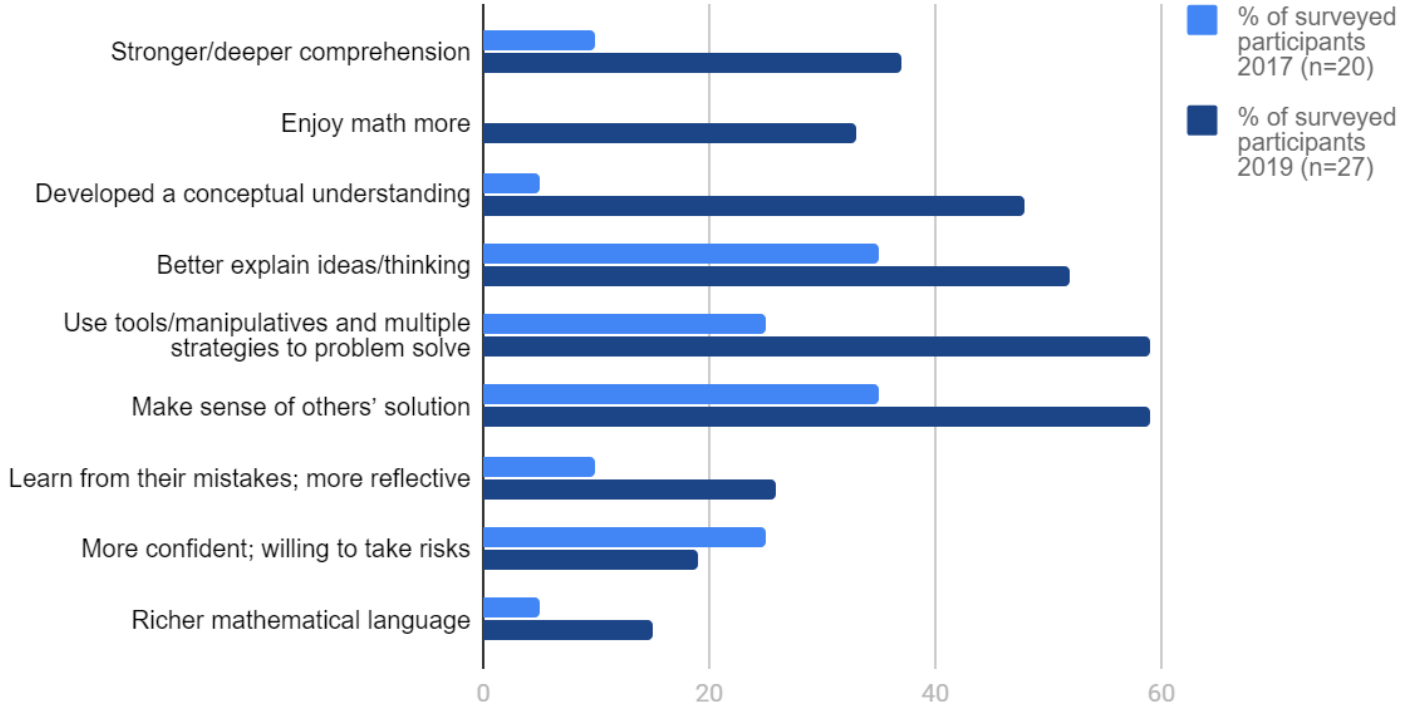
I strategically invite participation in ways that facilitate mathematical connections	❒	❒	❒	❒
I pose questions that deepen students' understanding or promote meaningful reflection	❒	❒	❒	❒
Encouraging Strategies & Methods				
I give students time to think about different ways to approach a problem	❒	❒	❒	❒
I encourage students to use their own strategies and methods	❒	❒	❒	❒
I ask students to compare different methods and explain why a strategy is a good choice	❒	❒	❒	❒
My students use manipulatives in the classroom to make sense of the mathematics	❒	❒	❒	❒
Encouraging Learning From Mistakes				
I explicitly discuss mathematical errors or misconceptions and how to overcome them	❒	❒	❒	❒
I encourage making multiple attempts	❒	❒	❒	❒
Evidence of Learning				
I use observations and students' responses to determine what students understand	❒	❒	❒	❒
I use student thinking to inform in-the-moment discourse	❒	❒	❒	❒
I use student thinking to inform future lessons	❒	❒	❒	❒

Level 5: Student Learning Outcomes

At this level, we are looking to establish to what extent the resulting shifts in instructional practice have had an impact on student learning. According to Guskey (2016), "*Level 5 addresses the bottom line in education: What was the impact on students? Did the professional learning benefit them in any way?".* To get a complete assessment of the impact on student learning, it is important to include multiple measures. However, the difficulty of analyzing this project from the *Student Learning Outcomes* perspective is that there are numerous factors that influence student learning. Therefore, since teachers are central to this professional learning, sources of evidence from their perspective is of particular importance.

In 2017 and 2019, 47 teachers and administrators from three participating boards were asked to reflect on how their professional learning in the Math Focus project has affected student learning. All teachers who responded expressed that they had noticed significant positive impact on student learning in several different areas of mathematical thinking and in student mindsets. Key aspects from the participant responses were summarized in the following table:

What are some of the ways in which student learning has changed as a result of the elementary math focus professional development, including the math summer institute? Briefly explain.



Respondents' feedback included:

- *"Students are beginning to have more confidence in their abilities as learners and are more willing to share their thinking with the class."*
- *"Love that the students discuss their strategies and work together to give each other feedback. This helps all the students learn new concepts and strategies."*
- "*My students have deepened their comprehension of mathematical concepts. They don't just learn « tricks » and strategies; they understand why they are doing it and can make sense of it*."
- "*I noticed that they make sense of each other's answers more. They can explain better, in their own words what they are doing and why."*
- "*My students, in general are more likely to persevere in finding solutions to problems or math activities. They don't give up as easily. They tend to take risks in trying different strategies*."
- "*Students are better able to explain their ideas and to use several tools to solve a problem.*"
- "*I love the way the students respect each other's thoughts and feel safe to make mistakes and share their ideas and strategies."*

Another resource which is currently in the preliminary stage of use but promises to be quite useful in directing teacher practice is *The Math Reasoning Inventory* (MRI) the creation of which was led by Marilyn Burns, the founder of Math Solutions. This online formative assessment tool provides information on the occurrence of both appropriate and inappropriate reasoning strategies and understandings of students. Two Cohorts of grade 6 students were interviewed using the Whole Numbers interview questions (one of the three assessments available). The students are asked one question at a time and are given plenty of think time. The interviewer uses the online platform to record their thinking. The data is then automatically compiled in a rubric. In the case of the few schools currently using this tool, the data has been used to identify which strategies needed more emphasis, and at what level within the school, thus a vertical planning approach was implemented. Moreover, as a result of interviewing students with the MRI, teachers have understood the importance of conceptual understanding as the data highlights very effectively the difference between procedural and conceptual understanding. They are also looking more closely at student thinking. A few schools have

committed to using this resource over the next five years to track progress and inform teacher practice. The MRI interviews resemble a math running record for conceptual understanding and could be used on a larger scale across the province to monitor change long term.

The current indicators on student learning outcomes indicate the math focus project has had a significant positive impact on student learning in several different areas of mathematical thinking and in student mindsets. Changes in students' mathematical thinking preliminarily indicate that students are showing a deeper conceptual comprehension and flexibility in approaching problem solving, can make better sense of others' solutions, and have increased their ability to explain and justify their thinking and solutions. Changes in student mindsets preliminarily indicate that students are showing increased engagement in discussions, becoming more confident and willing to take risks, are learning from their mistakes and have a more positive attitude towards math. The indicators of Guskey's level 5 impact on student learning outcome is currently based from the perspectives of teachers. To extend the analysis of this level of impact on student learning in future years, further sources of measures should also be monitored.

Conclusions

The purpose of the Math Focus Project is to shift the practice of mathematics teachers in Anglophone Quebec in order to improve student learning in mathematics. The impact of this professional development has been measured using Guskey's five critical levels of effective teacher professional development.

Overall, the outcomes on instructional practices and impact on student learning have been very positive.

- **In Level 1**: Participant Reactions
  Participants have indicated an overall appreciation of the quality of the presenters' facilitation and of the pacing of the sessions. Furthermore, participants positively indicated that the content of the workshop was representative of their needs and was appropriately selected.

- **Level 2:** Participant Learnings
  The steering committee has concluded that the content of the professional development was adapted to participant needs and aligned to the Quebec Educational Program. Ongoing monitoring of this level will need to be revisited as it can be a challenge to separate a participant's learning (level 2) from the application of their learning in practice (level 4).

- **Level 3:** Organization's Support and Change
  The organizational structure of spacing out the teacher learning over a three year commitment has been an effective organization design for teachers to deepen their understanding over time and build capacity. School boards and associations wrote plans and offered local support during the school year to maintain the momentum for local change. As well, the use of external experts to promote the program to principals, new secondary teacher recruits, and also to develop the math consultants' expertise, has been implemented.

- **Level 4:** Participant Use of New Knowledge, Skill and Attitude

  Teachers reported an increase in the use of manipulatives in the classroom to build student understanding, as well as an increase in classroom discussions whereby procedures to solve problems are student directed rather than imposed by the teacher. As a result of this work, new observational tools have been created that align with the NCTM to measure the application of these shifts in teachers' daily practice.

- **Level 5:** Student Learning Outcomes

  The current indicators on student learning outcomes, based on the perspective of teachers and administrators, indicate that the Math Focus Project has had a significant positive impact on student learning in several different areas of mathematical thinking and on student mindsets. Further sources of measures for this level are currently being explored to provide a deeper analysis of the impact on student learning in future years.

  The LCEEQ Math Focus Project also contains significant elements of all seven (7) of the hallmarks of effective professional development as illustrated by Darling-Hammond et al, from the Learning Policy Institute; it is content focused, incorporates active learning utilizing adult learning theory, supports collaboration in job-embedded contexts, uses models and modeling of effective practice, provides coaching and expert support, offers opportunities for feedback and reflection, and is of sustained duration.

  To conclude, the Math Focus Project is a multilayer and comprehensive professional development initiative. The initial analysis has demonstrated positive results in shifting instructional practices of mathematics teachers to impact student learning. To this effect, we recognize that continuous monitoring of the project and further exploration of measurement tools will help sustain the effectiveness of this professional development.

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Appendix A: Critical Levels of Professional Development Evaluation (Guskey, 2002)

Evaluation Level	Questions Addressed	Information Gathered	What is Measured/ Assessed	How the Information is Used
Level 1: Participants' Reactions	• Did they like it? • Was their time well spent? • Did the material make sense? • Will it be useful? • Was the leader knowledgeable and helpful? • Were the refreshments fresh and tasty? • Was the room the right temperature? • Were the chairs comfortable?	• Questionnaires administered at the end of the session	• Initial satisfaction with the experience	• To improve program design and delivery
Level 2: Participants' Learning	• Did the participants acquire the intended knowledge, beliefs, and skills?	• Pencil-and-paper instruments • Simulations • Demonstrations • Participant reflections (oral and/or written) • Participant portfolios	• New knowledge and skills of participants	• To improve program content, format, and organization
Level 3: Organization Support & Change	• What was the impact on the organization? • Did it affect organizational climate and procedures? • Was implementation advocated, facilitated, and supported? • Was the support public and overt? • Were problems addressed quickly and efficiently? • Were sufficient resources made available? • Were successes recognized and shared?	• District (school board/association) and school records • Minutes from follow-up meetings • Questionnaires • Structured interviews with participants and district or school administrators • Participant portfolios	• The organizations' advocacy, support, accommodation, facilitation and recognition.	• To document and improve organizational support • To inform future change efforts

Critical Levels of Professional Development Evaluation (Guskey, 2002) **Appendix A *(continued)***

Evaluation Level	Questions Addressed	Information Gathered	What is Measured/ Assessed	How the Information is Used
Level 4: Participants' Use of New Knowledge and Skill	• Did participants effectively apply the new knowledge and skills? • How are the participants using what they learned? • What challenge are participants encountering?	• Questionnaires • Structured interviews with participants and their supervisors • Participant reflections (oral and/or written) • Participant portfolios • Direct observations • Video or audio tapes	• Degree and quality of implementation.	• To document and improve the implementation of the program content
Level 5: Student Learning Outcomes	• What was the impact on the students? • Did it affect student performance or achievement? • Did it influence students' physical or emotional well-being? • Are students more confident as learners? • Is student attendance improving? • Are dropouts decreasing? • How does the new learning affect other aspects of the organization?	• Student records • School records • Questionnaires • Structured interviews with students, teachers and/or administrators • Participant portfolios	• Student learning outcomes: ○ Cognitive (performance and achievement) ○ Affective (Attitudes and dispositions) ○ Psychomotor (Skills and behaviours) ○ Student work samples ○ State/local assessments ○ Performance assessments	• To focus and improve all aspects of program design, implementation and follow-up • To demonstrate the overall impact of professional development

Appendix B: Content Delivery Plan by Grade Band

	Year 1	Year 2	Year 3

3-4	• Place value
	• CGI word problems (all operations)
	  ○ Multi-digit addition and subtraction (up to 5 digits)
	  ○ More examples and models for multiplication (product up to 5 digits) and division (3 digit divided by 1 digit)
	• Fractions:
	  ○ The different meanings of fractions (including the relationship between numerator and denominator)
	  ○ Represents fractions in a variety of ways
	  ○ Distinguishes numerator from denominator
	  ○ Matches a fraction to part of a whole or part of a group of objects
	  ○ Compares fractions, equivalent fractions
	  ○ Orders fractions (same denominator only)
		• Time/clock activities (estimates and measures time using conventional units)
		• Unpacks decimal concepts (up to hundredths):
		  o Represents decimals in a variety of ways
		  o Identifies equivalent representations
		  o Understands the role of the decimal point
		  o Compares decimals and arranges decimals in increasing or decreasing order
		  o Addition and subtraction of decimals
			• Area and Perimeter:
			  ○ Calculating area
			  ○ Calculating perimeter
			  ○ How to teach students to distinguish area and perimeter in context
			  o Emphasizing the meaning of area
			  o Linking area with multiplication (area model)
			• Introducing distributive property
			• Metric conversions
			• Multiplication and division of decimals (multiples of 10, hundredths x whole number)

5-7	• Multiplication and division problems:
	  ○ Problem types
	  ○ Multiplication of 3-digit by 2-digit
	  ○ Quotient of a 4-digit by 2-digit with remainder in hundredths
	  ○ More examples of models and strategies for both multiplication and division (ie: partial products/area model)
	• Fractions:
	  ○ The different meanings of fractions (including the relationship btw numerator and denominator)
	  ○ Represents fractions in a variety of ways
	  ○ Distinguishes numerator from denominator
	  ○ Matches a fraction to part of a whole or part of a group of objects
	  ○ Compares fractions, equivalent fractions
	  ○ Orders fractions (same numerator and same denominator)
		• Unpacks decimal concepts (up to hundredths):
		  ○ o Represents decimals in a variety of ways
		  ○ o Identifies equivalent representations
		  ○ o Understands the role of the decimal point
		  ○ o Compares decimals and arranges decimals in increasing or decreasing order
		  ○ Place value with decimals (up to thousandths)
		  ○ o Addition and subtraction of decimals
		• Fractions:
		  ○ Addition and subtraction
		  ○ Multiplication and division
		• Integers:
		  ○ Representing integers in various ways
		  ○ Locating integers on a number line and Cartesian Plane
		  ○ Comparing integers
		• Properties of Operations:
		  ○ Understanding associative, distributive, and commutative properties
			• Fractions, Decimals, and Percentages:
			  ○ Understanding the relationship between these concepts
			  ○ Making sense of percentage problems
			• Area and perimeter
			  ○ Calculating perimeter
			  ○ Calculating area (triangles, quadrilaterals and shapes that combine triangles and quadrilaterals)
			  ○ Emphasizing the meaning of area
			• Linking area with multiplication (area model)
			• Patterns:
			  ○ Analyzing number patterns
			  ○ Extending number patterns
			  ○ Analyzing geometric growth patterns

Content Delivery Plan by Grade Band

Appendix B (*continued*)

	Year 1	Year 2	Year 3
8-9	● Proportional Reasoning (ratios and proportions) ● Algebra ○ Algebraic expressions; solving equations ○ Methods for solving including Algebra Tiles, trial and error, various representations for solving, table of values ○ Some connections to linear functions ○ Connections to polynomials ○ Binomial x binomial (area model)	● Linear functions and systems ○ Graphically, table of values and comparison **only** ● Geometry, including: ○ Circle and sectors ○ Solid geometry, including surface area, volume, and similar solids	● Statistics (mean, median, mode) ● Box-and-whisker plot (quartiles) ● Operations on polynomials