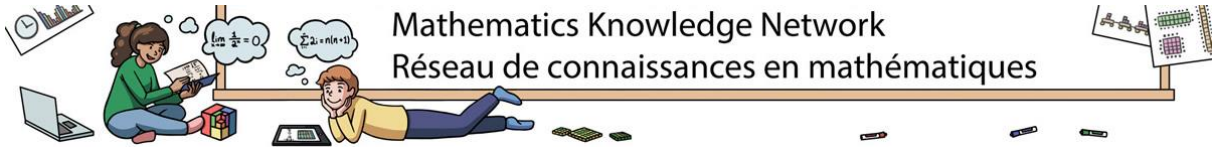

Mathematics Educator Leadership in Ontario (Research results)

Dragana Martinovic[1]

The recently initiated Renewed Math Strategy (RMS, 2016)[2] in Ontario, highlights importance of increased professional learning opportunities for teachers and principals as instructional leaders. The RMS requires that each elementary school has at least one math lead teacher to support mathematics teaching and learning in their school. Such new content leadership role requires that these math lead teachers work closely with their peers and school administrators. While researchers must still characterize "the mathematical knowledge and skills that leaders require" (Borko, Koellner, & Jacobs, 2014, p. 150)[3], the aim of the Mathematics Leadership Community of Practice (ML CoP) is to develop practice-informed models for supporting school-based mathematics leaders in their role. This CoP also seeks to mobilize other leaders in the Province, including those who are school-board-based and faculty of education-based, with the idea that working collectively, we can provide adequate support to teachers, thus reaching every classroom and every child.

To achieve its goals, the ML CoP works with partners across the Province which include faculties of education, school boards, leadership networks, teacher informal groups, professional organizations, and individuals (see Figure 1). This allows for both vertical and lateral system's learning; vertical, through case studies of particular schools, boards, and networks; and lateral, that includes exchange of knowledge and learning between educators in the Province.

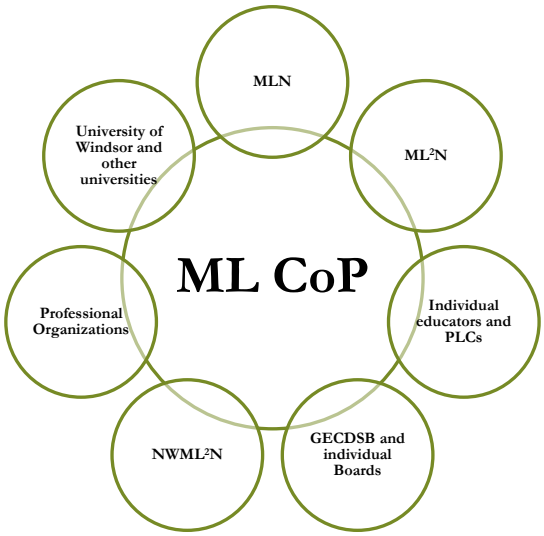

Figure 1. Current Members of the Mathematics Leadership Community of Practice

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[1] On behalf of the ML CoP research team: Dragana Martinovic and Heidi Horn-Olivito, with Nesreen Elkord and Ziad Dabaja as research assistants.

[2] Ontario Ministry of Education. (2016). Renewed math strategy. Retrieved September 26, 2016, from www.edu.gov.on.ca/eng/policyfunding/memos/april2016/min_math_strategy.html

[3] Borko, H., Koellner, K., & Jacobs, J. (2014). Examining novice teacher leaders' facilitation of mathematics professional development. Journal of Mathematical Behavior, 33, 149-167.

In many ways our work is related to better understanding and redefining teaching profession. As Fullan emphasized, if we "are going to get breakthrough results innovation must come from teachers working in collaboration" (2011, pp. 7-8)[4]. Along these lines, the ML CoP is envisioned as an interactive system which connects networks, organizations and individuals, to support development of both *human capital* (e.g., through formal education—teacher education, AQ courses, and on-the-job experience) and *social capital* (e.g., through frequent teacher conversations about mathematics instruction—content and pedagogy, and enhanced trust and closeness between peers).

The Ontario Ministry of Education (2011)[5], Paying Attention to Mathematics, identifies several key features of effective leadership of mathematics:

- ensuring ongoing and differentiated professional learning in mathematics for educators across the system;
- ensuring supports are in place to promote networking of school leaders at the board, school and classroom level;
- learning what good mathematics looks like in order to reflect on good practice – by participating in co-learning, co-planning and co-teaching;
- encouraging risk-taking and innovation by providing a safe environment for co-learning;
- encouraging collaboration through joint planning, shared debriefing, observation of teaching and key conversations on how practice informs learning; and
- supporting parent involvement by helping them understand shifts in the teaching and learning of mathematics. (p. 5)

In this report[6] we tackled these aspects highlighted by the Ministry and identified educators' needs in becoming effective leaders of mathematics. Teacher-leaders hold vital roles in schools. Sometimes the role is formally assigned and other times it is an informal structure entrenched in the culture of a school. Traditionally, teacher-leaders have been educators who serve as mentors, resource providers and curriculum leaders. Over time, the role has developed through the structures like Student Work Study and Collaborative Inquiry to include research and innovation. Our renewed provincial focus on mathematics education has created another interesting opportunity for this role to transform further. However, as the teacher-leadership continues to develop, we need to explore the function, the models, as well as enablers and limitations/challenges of school-based math leaders.

In the further text we briefly describe our ongoing collective investigation and associated activities, and connect preliminary (current) findings to the literature reviews we completed. This report will be annually revised to address our recent activities and new data, and relate those to the findings of others. In that way, this is a growing and living document which will detail our work and inform further research-practice-policy conversations about mathematics educator leadership in Ontario.

Methodology

The ML CoP member organizations were monitoring the undertaken professional development (PD) activities. Both "top-down" (focusing on superintendents, system leaders, and school administrators) and "bottom-up" (focusing on practicing teachers and school math leads) approaches to PD were implemented. For the purpose of knowledge mobilization, lateral communication and exchange of resources among educator communities occurred through the web sites, Tweets, online meetings (e.g., Google Hangout), webcasts, Internet radio programs, and so on.

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[4] Fullan, M. (2011). Learning is the work. Retrieved from michaelfullan.ca/wp-content/uploads/2016/06/13396087260.pdf

[5] http://www.edu.gov.on.ca/eng/teachers/studentsuccess/FoundationPrincipals.pdf

[6] Please note that in this report we do not present findings from all our member organizations, either because we did not receive them on time, or they may be in initial stages of data collection.

Our research questions included:

(RQ1) How do educators define mathematics leadership?
(RQ2) What are professional learning needs of mathematics leaders in Ontario?
(RQ3) What evidence do we have that different initiatives conducted by the ML CoP and its member organizations are successful in changing practice in schools?

To answer the first and second questions—to understand mathematics leadership, its potentials and current challenges—we conducted an extensive literature review, a case study of one school board, and also collated and summarized results of data analyses from the member networks.

To answer the question: "How do educators define mathematics leadership?" we have used a case study research method (Yin, 2013)[7]. Case study is useful in answering "'how' questions because these deal with operational links to be traced over time" (Benbasat et al., 1987, p. 371)[8]. As part of the case study, we conducted surveys with math leads at the GECDSB asking questions about their role and their needs. Similar surveys with math leads will be periodically conducted, to capture change in their attitude and confidence, as well as aspects of their work. We also started with six whole school inquires (see the Case Study document) at the GECDSB.

To identify the professional learning needs of mathematics leaders in Ontario, our member networks have organized different PD events for superintendents, system and instructional leaders, and principals of the participating school boards. Activity-based monitoring that captures current understanding and knowledge is combined with collecting direct feedback of participants. The networks have embedded ongoing formative assessment/research strategies to identify the learning needs and inform next steps in planning. Usually, during the meetings they would collect data using Padlet technology, and after the events, use exit cards and exit surveys. They monitor Tweets and collect other Web-based analytics and share them with the CoP. The networks also collect data from their participants through interviews where the participants are able to reflect on the content as well as their own practice.

In addition to what we learned through the data collected in GECDSB, these networks' data have helped us to better understand aspects of mathematics leadership, to evaluate the needs of the participating educators, and appropriateness of PD activities organized.

To answer the question about the evidence of changed practice, our member organizations have conducted surveys after each initiative and asked educators about their past and present practice, as well as about their next leadership moves. The activities and preliminary (current) findings are provided in the further text after introducing some of our member organizations and activities.

Context and Instrumentation

GECDSB: Developing understanding of mathematics content leadership

The Greater Essex County District School Board (GECDSB) has 56 elementary and 15 secondary schools, adult education and three agency schools, with approximately 35,000 students and 4,700 employees. The Board has a long-standing relationship with community and provincial partners. Since 2010, the GECDSB has partnered with the University of Windsor in a Collaborative Inquiry project which has impacted the practice of hundreds of teachers and influenced the structures of the entire system. These educator-led projects have influenced the growth of school-based leadership which is now a common structure across the GECDSB.

[7] Yin, R. K. (2013). Case study research: Design and methods. Beverly Hills: Sage publications.
[8] Benbasat, I., Goldstein, D. K., & Mead, M. (1987). The case research strategy in studies of information systems. MIS Quarterly, 11(3), 369–386.

Clear articulation of the level of skill/ capacity of each mathematics leader would help all boards to structure capacity building that is targeted and focused.

Implemented in 2016-17, in elementary schools, the board formed Math Learning Teams (MLTs) which included: administrators, primary/junior/intermediate division leads, and special education teachers. The teams in secondary schools included a Mathematics Department Head, and teacher representatives of academic/applied/locally developed courses.

The board first conducted a series of Administrative Capacity Training (ACT) sessions. These full days of learning were specifically designed to support Administrators in leading mathematics learning in their schools. By December of 2016 the ACT met three times and the feedback from Administrators indicated that they preferred to learn mathematics with their school team. Thus all further sessions were designed for the entire Math Learning Team (MLT). In 2017 the board organized a variety of capacity building sessions, workshops, book talks, and school-based learning opportunities to support the school-based MLTs to enhance their practice as leaders of mathematics education.

These meetings provided an opportunity to collect data in relation to the following questions: *How do members of MLTs understand their role? What challenges do they see for their particular role on the team? What is the confidence level of members of the MLTs?*

In the spring of 2017 the board collected data regarding the perspectives and attitudes of the MLTs and their constructs of mathematics leadership. The data consisted of transcripts from the focus groups with MLTs and online questionnaires, as well as PD facilitators' reflections. Also, in the spring of 2017, six schools in the GECDSB began their work on the Mathematics Leadership Learning Project (MLLP). These whole school inquiries were documented and their intermediate results reported as a case study in a separate document.

MLN: Developing the capacity of educational leaders with system responsibilities

The Northeastern Ontario Mathematics Leadership Network (MLN) consists of 48 members that include eight School Boards (with up to 5 system leaders/board), 3 School Authorities, and the Ministry Field Team. This network, centered in Sudbury, investigates impact of Additional Qualifications (AQ) learning on system leadership teams responsible for implementing RMS and looks for evidence of increase in collective leadership efficacy. The MLN also experiments with new online structures (e.g., Not a Book Study) that can support wide-scale learning opportunities for educators.

The MLN has started in 2016 and is now in its second year. At the end of its first year, its members were invited to share how their individual vision of effective mathematics learning and teaching shifted since the start of MLN. Here are some responses in which the MLN members particularly addressed their leadership roles:

> *I have learned that setting up the specific conditions to foster teacher and student efficacy is the most important strategy. Originally, this was just something that was "part" of effective mathematics learning and teaching and now, I believe (Hattie says so), it is the MOST important factor.*
>
> *Understanding that in my role as principal my teachers need time to digest, discuss, try out, fail and try again. This needs patience and perseverance from all. Reminding myself that small changes and successes are powerful and need to be celebrated.*
>
> *My shift is not so much a change but a deepening of my understanding. I can name the math that I see kids doing and identify their thinking along with naming the strategies that can help move their thinking forward.*

As a system coordinator for summer learning programs I would like to ensure our math teachers have taken the mathematical mindset course by Jo Boaler and that the student course is a mandatory component of the program.

The network regularly collects data for monitoring purposes. Between April and July, the MLN conducted three surveys.

The MLN April 2017 Survey

The survey consisted of 30 items, 13 of which addressed leadership aspects, 12 related to their self-confidence with mathematics, and the rest were demographics questions. A total of 32 educators completed the survey: 5 Superintendents, 8 school administrators, and 17 instructional leads (one person selected "other" as a role and another person did not provide a role).

The MLN July 2017 Exit Survey

In July 2017, the MLN conducted an exit survey after their three-day long professional learning meeting. There were 18 respondents: four superintendents, six instructional leads, two system administrators, and six school administrators.

The MLN 2017 Not a Book Study Exit Survey

In 2017, the MLN organized a Not a Book Study activity, open to all educators interested in expanding their knowledge of mathematics and mathematics pedagogy. The purpose of this activity was:

1. To begin to change practice (to a constructivist approach to teaching mathematics) at the classroom level by providing:
    a. Access to high quality learning
    b. Differentiated entry points
    c. Encouraging self-directed learning and reflection
2. To provide quality professional learning opportunities to widely scattered (geographically) educators, including:
    a. Choice of opportunities for learning
    b. Choice of platforms for conversations and discussions
    c. Self-directed professional learning
3. To begin to build a network of learners across the northeastern region and around the province, by encouraging:
    a. Open online conversations on multiple platforms
    b. Documentation of learning shared openly in multiple formats
    c. Scaffolded access to artefacts of learning through a single open access point (website)

Thirty five educators participated in the survey: 9 teachers, 6 math leads, 1 Ministry of Education personnel, 4 P/VP, 2 Senior Administrators, and 13 Central Board Staff. They were administered an online survey with 19 questions, five of which were of the open answer type, and five of which contained multiple sub-questions. Most questions/statements offered respondents opportunity to select an option from a scale (e.g., 0-3; Strongly Disagree to Strongly Agree; Not Valuable to Valuable).

ML²N Interviews: Key components of an effective mathematics leadership learning network

The Mathematics Leadership Learning Network (ML²N) is a collaborative networked learning partnership between seven of the Barrie Region District School Boards and the Ministry of Education Barrie Region Student Achievement Division Field Team. Participant teams are comprised of Family of Schools Superintendents, Principals/Vice-principals of RMS intensive/increased support schools, and a system support person—in total, 57 leaders from 7 of our 11 Barrie Boards, including 14 Superintendents, 5 System Principals, 6 Math Coaches/Facilitators, and 32 School Leaders (Principals/Vice-Principals). Twenty ML²N leaders are currently taking the AQ Part One course. The ML²N has a goal to build both capacity, as well as

individual and collective efficacy, of superintendents of education and school administrators in mathematics knowledge for leading.

After the May 2017 meeting, the ML²N facilitators interviewed seven members who at that time played different leadership roles at schools/school boards. The interviewees were asked to elaborate on:

- A learning network/networks that they are a part of (including but not limited to the ML²N) and how this network influences their leadership.
- The pedagogical knowledge they need to influence how mathematics is taught in their school(s).
- The mathematical content knowledge needed to influence how math is taught in their school(s).
- The professional learning they have led with their staff, including some considerations in the design and implementation that have made it effective. How do they know if it was effective? What structures and time components work?
- The feedback loops that are built into their network to help with implementation.

The interviewees listed leadership involvement in different capacities: school administrator, board consultant, school health and safety leader, board leader, superintendent, and special education leader. Within the scope of their leadership, they became members of different professional networks. Their perceptions of the networks they participated in varied from one interviewee to the other. Nevertheless, the agreement among most of them was that professional networks were important for the development of their practice in their roles as leaders, because they: (a) provide opportunities for social connections; (b) encourage system-wide thinking; and (c) inform practice.

The ML²N also collects research data through networking cards, leadership placemats, and a world café visual representation of the thinking of the participants. The data collected indicate a willingness of school and system leaders to network with cross-board colleagues to share knowledge of math content and pedagogy. As well, together, the leaders are more easily able to identify leadership practices needed (e.g., when strong instruction is not evident) and other leadership practices, including facilitating effective collaborative inquiry.

Discussion of Findings

The data collected in different parts of Ontario and with educators with different leadership assignments allow us to see some patterns in the early stages of activities and partnerships that support the Ontario-wide RMS initiative. We are also seeing strong connection to what we found in the emerging literature on the content leadership.

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I. Our first research question was to find how educators define mathematics leadership. Surveys done with math leads show that we are in initial stages of helping them to blossom into teacher leaders. These findings allowed us to make a parallel with the research literature on teacher leadership. The data gathered thus far reveal that:

1. Educators have varying definitions of mathematics leadership

The GECDSB educators (see the case study document), described their leadership role that we clustered under the following terms: Broadcaster (e.g., "*Share the knowledge I've been given*"; "*Pass on information to staff from [PD] sessions*"), Resource (e.g., "*Someone who colleagues can come to for assistance or ideas in teaching math concepts using concrete/manipulatives*"), Co-learner (e.g., "*I think I am ALWAYS going to be learning along with my staff. I think that's my role*"), Facilitator (e.g., "*As a conductor of items learned, and as someone who can dictate the direction of our math focus/instruction*"), Lead Learner (e.g., "*I see my role as a lead learner -- literally an example to others that it is possible*"; "*In addition to being an administrator, I am also a lead learner, allowing teachers to partner with my class and not feel so at risk. When I put myself out there as a learner, the teachers are more willing to try new things too.*"), Change-maker (e.g.,

"*Creating positive mindsets and open mindedness to change*"; "*My role is to shift the culture within my school so that all teachers embrace new math learning*").

The ML²N participants were clear that there is no formula for leadership (it is contextual), and they emphasized modelling and mentoring as their roles.

The MLN Principal saw his/her role as the one who creates a safe environment for the staff to "try out, fail, and try again."

These findings are consistent with Downton and Sexton's (2014)[9] findings that educators in different leadership positions view their content leadership in different ways. They also align with the Ontario Ministry of Education (2011) aspects of effective leadership (i.e., "ensuring ongoing and differentiated professional learning in mathematics for educators across the system", p. 5), with the addendum that educators who are in the (content) leadership roles also need such learning opportunities.

2. School-based math leads do not necessarily identify themselves as leaders or agents of change.

How leadership is generally viewed determines the set of actions taken in the process of supporting school teachers. As Lambert (2002)[10] posits,

> *Our lesson is clear: Instructional leadership must be a shared, community undertaking. Leadership is the professional work of everyone in the school. (Lambert, 2002, p. 37)*

- Everyone has the right, responsibility, and ability to be a leader.
- How we define leadership influences how people will participate.
- Educators yearn to be more fully who they are—purposeful, professional human beings. Leadership is an essential aspect of an educator's professional life. (p. 37)

In our first year of existence, we found that many educators perceive their mathematics leadership roles as undefined/challenging/stressful. The GECDSB educators used the following word to describe their mathematics leadership role: "*Generic. Undefined. Confusing*"; "*Challenging*"; "*As an added stress*"; "*I'm very unclear on my role as a math lead-learner*"; "*Challenging*"; "*Still a learner not a full leader*"; "*I am not comfortable being a math lead as I do not possess the needed knowledge at this point in time*"; "*I feel I need more time as a learner before I feel comfortable being a leader*"; "*I am a co-learner and risk-taker. Knowledge base is limited.*"

Similar to the findings of Fairman and Mackenzie (2015)[11], we found that math leads shy away of being called leaders. Here is a reflection from a GECDSB facilitator of meetings with math leads:

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[9] Downton, A. & Sexton, M. (2014). School mathematics leaders' beliefs about their role when participating in a school mathematics project. *Australian Primary Mathematics Classroom*, *19*(3), 1-5.

[10] Lambert, L. (2002). A Framework for Shared Leadership. Educational Leadership, 59(8), 37-40.

[11] Fairman, J., & Mackenzie, S. (2012). Spheres of teacher leadership action for learning. Professional development in education: Teacher leadership and professional development, special issue, 38, 229–246.

It was striking to see how uncomfortable the teachers were with the idea of leadership…

Our conversation began with a discussion prompt, "what is mathematics education leadership?" It was difficult to describe, and the collective agreed that they were not leaders. They wanted to be collaborators, who shared ideas with staff, learned together, figured things out together, pressed for change in subtle, collegial, collaborative ways. For these teachers this was not leadership. One teacher remarked, "I don't look at it as leadership, I look at it as collaboration. It looks like us working together to learn more. It isn't about us telling people "do this," it is about us working together."

If one's definition of leadership is predicated on the idea of authority, then it is understandable that these teachers do not see themselves as leaders. The issue is not their plans, ideas or actions, it is that they have long been immersed in a world where boss and leader where intermingled terms. These terms are, in fact, not the same thing, but this may be something that these educators need to discover. They are leaders. I see it and I believe they will, in time.

(GECDSB facilitator)

On that note, Fairman and Mackenzie (2015) propose that "in advancing the focus on school improvement and a shared accountability for the learning of all children, the term 'teacher leader' may be counterproductive" (p. 61). Knapp (2017)[12] suggests that being confused about leadership role, navigating the middle ground between colleague and leader, and lacking effective communication with school administration hinder the process of becoming a teacher leader. As her leadership identity transitioned, Knapp found that adopting a lead-by-example and lead-learner stance supported her work with colleagues. While this safe route is obviously being adopted among educators across Ontario, we think that the concept of 'leader' as equivalent to 'boss' or 'manager', that seems to be prevalent among educators, needs to be challenged. Educators need to espouse the idea that in a society built on the principles of distributed leadership (Goleman, Boyatzis, & McKee, 2002)[13], every person can eventually in some situation act as a leader. For this to happen, leaders who are helping others (e.g., peers, students) mature into leaders, are especially needed (Fullan, 2005[14]; Harris, 2005[15]).

In his theory of becoming a teacher leader, Dawson (2010)[16] maintains that in order to develop confidence in a range of leadership capacities, as well as to see themselves as teacher leaders, educators need to experience learning and leading in a safe environment over an extended period of at least two years. The safe environment in which teachers can learn ("try out, fail, and try again") and lead would allow them to experience success in leading and to develop necessary confidence. "If, for any reason, the environment becomes unsafe, many teachers will quickly retreat from the leadership role back to the relative safety of the classroom" (p. 98).

This aspect is especially relevant for one of the Ontario Ministry of Education (2011) key features of effective leadership of mathematics, namely to "encouraging risk-taking and innovation by providing a safe environment for co-learning" (p. 5). The notion that such an environment needs to be lasting (i.e., at least two years, Dawson, 2010), is particularly informative.

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[12] Knapp, M. C. (2017). An autoethnography of a (reluctant) teacher leader. The Journal of Mathematical Behavior, 46, 251–266.

[13] Goleman, D., Boyatzis, R., & McKee, A. (2002). Primal leadership: Realizing the Power of Emotional Intelligence? Boston, MA: Harvard Business School Press.

[14] Fullan, M. (2005). Leadership and sustainability: System thinkers in action. Thousand Oaks, CA: Corwin Press.

[15] Harris, A. (2005). Crossing boundaries and breaking barriers: Distributing leadership in schools. iNET pamphlet. London, England: Specialist Schools Trust. Retrieved from http://www.almaharris.co.uk/files/distributed_leadership_pamphlet.pdf

[16] Dawson, M. K. (2010). Becoming a teacher leader: A grounded theory study. An unpublished Doctoral Thesis, University of Southern Queensland.

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II. Our second research question asked to identify professional learning needs of mathematics leaders in Ontario. Here are some of our findings:

3. Capacity (pedagogy, leadership and content) must vary depending on the role

This year, the professional learning opportunities for educators in Ontario varied significantly. The members of our ML CoP had opportunities to take some AQ courses. This was a voluntary option in all three networks (MLN, ML²N, and NW ML²N) and was embraced by many teachers, program staff, school administrators, and superintendents, even if their position did not require such course, but they took it anyway. The MLN led Not a Book Study, an open professional learning for all educators in the province. Other opportunities for learning involved facilitated meetings with school math teams/math leads at the GECDSB, as well as multiple 2-3 day professional development meetings with the teams from the member school boards and school authorities, organized by the networks. Schools were supported as they were starting their whole school inquires related to improving student engagement and Pedagogical Content Knowledge (PCK) of educators. Presently, we have results from the six school inquires conducted at GECDSB (see the case study report) and we will have much more to report in the future.

Throughout the year, we asked educators about their confidence level and their needs. The MLN findings show that in April 2017 (at the end of its first year) its members felt moderately confident with having sufficient mathematics knowledge to influence how mathematics is taught in their schools and to lead their staff in learning mathematics. It seems that they were less confident in motivating all staff to engage in learning to improve achievement for all students in mathematics, as well as in knowing how mathematics content is most effectively taught across grades. Most teams in all networks needed more support in collecting, interpreting and using data to monitor and determine next steps. While at least one third of the time in all networks' 2017 meetings was dedicated to the issues related to collaborative inquiry and monitoring, educators continued to raise the issue of implementation difficulties—monitoring the system, as well as analyzing, managing, and sharing the collected data.

> *How are we leading? How are we learning? How are we serving? And do our theory of actions really get at that? And then are our actions okay, are we going to be able to monitor those, and if not, what do we need to do, what do we need to change, what we need to do to be able to do it? (ML²N Board Consultant)*

The MLN survey also pointed to the divisional boundaries that most educators adhere to. We concluded that one of the goals of our work must be to help all educators understand development of mathematics ideas from K-8 and not to be satisfied to know mathematics that they teach/taught (i.e., Primary Grades (K-3), Junior Grades (4-6), or Intermediate Grades (7-10)).

We also noted that Instructional Leads in the MLN survey had the largest spread of the perceived mathematics leadership confidence (as measured by the survey, and compared to Superintendents and school administrators). Almost half of them had the confidence spread around 'very little' to 'some degree.'

After the July 2017 face-to-face session, for most of the MLN members (superintendents, instructional leads, system administrators, and school administrators) "Deepening understanding of the relationship between content and pedagogy," "Connecting assessment, instruction and the elements of universal design to meet the needs of all learners" and "Having dedicated time to meet with my team," best supported their then current professional needs.

The ML²N facilitators asked participants what mathematical content knowledge leaders in different roles need to possess in order to influence change in their schools. A school administrator believed that many educators assigned to be mathematics leaders "*are not necessarily science and math folks, and they're much more comfortable with the literacy realm and now we're putting them in a position where they need to lead math, and they may not have the confidence to do that.*" In this sense, he argued that "*the content piece is critical, it's vital, we need to know the content but we also need to know how to teach it.*" The superintendent participant similarly argued: "*So, as our principals, I think they have to know enough content to know what to question; but, do they have to be able to go in and teach the math? Not necessarily.*"

One GECDSB math lead said:

> *I don't think it is that teachers don't understand the math, it is that they have an incomplete understanding. They know one way, heavy procedures and don't always see the connections between concepts. We are very burdened by the strands and the reporting structure. This is a huge issue.*

Participants in one of the GECDSB's administrative capacity sessions asked:

> *How do we set-up tasks for staff? How do we get comfortable with math teaching? If we didn't have to report on 5 strands what would assessment and evaluation look like? If we had no text book how would you teach math? How do we lead this? What does high-quality teaching and learning look like? How do we better understand our curriculum?*
>
> *What questions do I ask kids? Staff? How do we best support parents? What manipulatives? When? Why? When do kids not 'need' them? When do they need them again? What is 'task' really?*
>
> And: *"When do I have time to do this work? It is so big."*

Time is a big issue for all educators. During a July 2017 MLN meeting, most participants asked for more time to deepen new knowledge or to work on tasks and have more opportunities to work with their school/board team. Also, educators who took part of the MLN's Not a Book Study claimed to have spent on average 2.9 hours per week learning (min = 1.5h, max = 8h). Almost half of respondents, and especially two-thirds of the Central Board Staff found it difficult to find time to participate in these activities.

These results are consistent with what we found in research literature. Pollock, Wang and Hauseman (2014)[17] wrote how the principals of elementary and secondary schools in Ontario reported being overworked and lacking time for PD. Principals asked for "More time for professional development so that we can share that with staff" (p. 32-33). The project team recommended that principals "seek out training around four key areas: emotional intelligence/relationship-building; communication skills, knowledge of teaching and learning; and mental health and wellness" (p. 37), while Cooper et al.'s (2016)[18] suggested that principals may also need specific training regarding aspects of team building and distributed leadership. Fennel, Kobett and Wray (2013)[19] suggested that elementary school math leaders consider the needs of colleagues as adult learners, by being mindful of their time, curriculum stressors, and personal lives.

Our impression from the meetings and based on survey responses is that educators in Ontario are willing to learn and are appreciative of the efforts that facilitators put into organizing these learning opportunities. It is recommended that we organize them in consecutive, shorter bursts, so that more people can participate and find what is relevant to their learning needs and interests. When using online technology, the boards/schools and facilitators should provide multiple training options to make transition into online learning as smooth as possible.

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[17] Pollock, K., Wang, F., & Hauseman, D. (2014). The changing nature of principals' work, Final Report for the Ontario Principals' Council, Toronto, ON, Canada.

[18] Cooper, K. S., Stanulis, R. N., Brondyk, S. K., Hamilton, E. R., Macaluso, M., & Meier, J. A. (2016). The teacher leadership process: Attempting change within embedded systems. Educ. Change, 17, 85–113.

[19] Fennell, F., Kobett, B. C., & Wray, J. A. (2013). Elementary Mathematics Leaders. Teaching children mathematics, 20(3), 172-180.

Technology should not be a barrier for Ontario educators to learn, collaborate, and teach, but an enabler!

4. *Effective professional learning must be connected to school and classroom practice.*

Consistent with Downton and Sexton (2014), we concluded that educators in different leadership positions need to receive a targeted PD. One consultant interviewed by the ML²N facilitators declared that the form of PD work implemented within his work depended upon a number of factors including,

> *who we are actually writing for, writing it for principals, writing it for educators, or are we actually getting the whole board in that, and are we monitoring that then? Why would we want to monitor, what are our actions and how are they going to get at whatever component we're looking at?*

He also emphasized that in designing PD, they have been focused on including participants' voices for more enhancements in future planning. By always collecting survey data at the end of PD the facilitators are better informed on whether or not they met the learning goals for their staff. This practice of getting feedback after every meeting/PD, was followed by all of the ML CoP members.

How to connect PD to school and classroom practice?

Depaepe, Verschaffel, and Kelchtermans (2013)[20] recommend that PD intended to increase teachers' PCK should not be separated from the classroom. To see if the PD had effect, classroom observations could be triangulated with "stimulated recall in which teachers can document their choices and justifications" (p. 23) during teaching.

In their Problem-Solving Cycle (PSC) model of mathematics PD, Borko, Koellner, and Jacobs' (2014) used videos of teachers' classroom instruction, focusing on student thinking and providing teachers with opportunities to make connections to their own instructional practice.

Another possibility is that school administrators observe the teaching for the purpose of providing teachers with some feedback. For such instances to be effective, administrators need to be "knowledgeable about instruction that facilitates students' construction of knowledge and […] able to observe carefully and sensitively" (Nelson & Sassi, p. 554)[21]. In other words,

> *Rather than simply looking for a more contemporary set of categorical elements of instruction—manipulatives, small-group work, mathematical discussion—as indicators of good instruction, administrators will need to pay attention to how these elements are used to support the development of mathematical thinking. Now, the content of the observation is mathematical ideas and the strategy for observation is to understand how the teacher's decisions support the development of mathematical ideas on the part of the students. (p. 560)*

> *Looking for the absence or presence of professionally accepted practices and routines such as wait time, or discussing with the teacher issues of pedagogical process such as the nature of questioning, is not enough. Administrators need to be able to discern the central intellectual ideas of the lesson and to pay attention to how they are being developed within the classroom's structures and practices. This is a major shift for many administrators, who may be more familiar with checklist approaches and other categorically based evaluation tools in which pedagogical process is evaluated independently of content. (p. 574)*

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[20] Depaepe, F., Verschaffel, L., & Kelchtermans, G. (2013). Pedagogical content knowledge: A systematic review of the way in which the concept has pervaded mathematics educational research. Teach. Teach. Educ., 34, 12–25.
[21] Nelson, B. S., & Sassi, A. (2000). Shifting approaches to supervision: The case of math supervision. Educational Administration Quarterly, 36, 553-584.

In one of the ML²N boards, the leadership team took another direction. A board leader explained, "*a whole lot of it was about data gathering; really knowing where our needs are. September and October was a lot about digging through the data and finding what specifically and focused things can we work on.*" He also added, "*So, in terms of designing and implementing that professional development, that's the approach we took—starting with the data, finding their needs and then doing the work.*"

Yet another option is to investigate collaborative practices that support teacher learning. The GECDSB facilitators developed Moderating Mathematics, a school-based professional learning model. While it is initially lead by a Mathematics Facilitator, Coach, or Mathematics Lead, the goal of the Facilitator is to support the professional learning community through the process until the group is confident enough to lead their own learning. Building educator efficacy and leadership is a central goal of this process and is what contributes to its sustainability over time. The facilitators' team concluded:

- The classroom is the unit of learning. It is therefore vital that all learning connects back to the instruction that is happening in classrooms. The classroom learning site is the location for the last part of the Moderating Mathematics process and the most important one.
- Recording student learning through observation and pedagogical documentation is a key part of moderation. It is the way in which educators are able to dig deeply into the student learning experience and which informs their pedagogical moves.
- All professional learning should serve to support what is happening in the classroom and inform professional judgement. The process of moderating mathematics is a cyclical process and is centered on the student learning experience. As the students' mathematical thinking changes, so does the focus of the professional learning, and so this process evolves with it.

This aspect is also aligned with the Ontario Ministry of Education (2011) instructions for effective leadership, and specifically to "encouraging collaboration through joint planning, shared debriefing, observation of teaching and key conversations on how practice informs learning" (p. 5). The focus on student learning, collaborative analysis of student work, collaboration of educators across divisions and grade levels is a promising model of professional learning (see the Moderating Mathematics Guide, developed at GECDSB).

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III. Our last research question was related to finding evidence that different initiatives conducted by the ML CoP and its member organizations are successful in changing practice in schools.

All respondents in the MLN April survey agreed with a statement: "I believe that the MLN will have a positive impact on my school system." With respect to positive disposition towards mathematics (I enjoy mathematics; I believe that I am the type of person who is able to learn mathematics, will persevere to solve a math problem that I find challenging,…), there was a statistically significant difference between educators who participated in the first year of MLN and those who did not, favouring those who have been with the MLN from the start.

When elaborating on the 2-3 most important ways that participation in the MLN has impacted them, the respondents to a July MLN survey have suggested a plethora of MLN impact, such as leadership development, learning network building, and deeper understanding of mathematics content as well as pedagogical knowledge. Also, it seems that engaging in MLN has encouraged participants to revisit their practices and induce changes. One school administrator advanced, "[*t]he MLN has allowed me to reflect on my leadership and enable[d] me to get more involved in student learning as well as engage teachers to look at their own professional practice.*"

The MLN members were also asked to elaborate on: "If we asked those who work with you what you are doing differently today compared to a year ago, what would they say?" Some participants felt that they have improved compared to a year ago by becoming, for instance, *"better at collaborating*," more intentional and

precise, and even creative vis-à-vis mathematics instruction. Others pointed out that today they would listen more to the ideas of others, deeply dwell on mathematics and its pedagogy, and focus on the students' reasoning and thinking rather than on the answer. One school administrator even suggested that her/his "*professional conversation has changed*."

The participants of the ML²N shared similar comments on the value of learning in a collaborative network focused on mathematics leadership content and pedagogy. One participant suggested that she has gone from "*Math-Phobic to Math Excitement!!*" Another participant reflected on how the learning from the ML²N will be used in practice:

> *I have already learned more content in this course in mathematics than I have learned in years. I feel that I am already starting to put a plan in place for the new school I will be working at in September. I have started talking with other educators about the importance of the guides to effective instruction, about the excellent resources we have been provided with and where I believe most teachers need to dive deeper.*

Creating an excitement for learning is a positive immediate outcome of the network. There were several similar comments like this one that was gathered from one of the AQ participants, "*This course is exactly what is needed. I would like to see more people take it as it really does provide so much of the information we need to be effective in our support to schools and it goes a long way into filling in the gaps of understanding that exist in our own math content knowledge.*"

The MLN's Not a Book Study survey focused on the impact of this online professional learning on educators' professional practice. The responses suggested that this learning experience has helped participants to deepen their understandings and knowledge vis-à-vis mathematical content and its connection to pedagogy, especially in the aspects of multiplication and division. Educators highly valued the #notabookstudy contribution to their understanding of how children learn, and how to teach children. Educators further claimed that during #notabookstudy, on average they connected to 4.4 new educators within their board, as well as to 6.7 new educators outside their board.

On a scale 1 = "Not very likely" to 5 = "Yes, I would be most likely to participate," 75% of respondents selected the highest value (i.e., 5) when answering the question "How likely are you to participate in professional learning similar to #notabookstudy in the future?", while no one selected values 1-2. All the respondents agreed or strongly agreed with the statements: "After #notabookstudy, I am more likely to recommend online self-directed professional learning to other educators" and "I feel that #notabookstudy added value to my professional practice."

We conclude that the MLN facilitators were successful in engaging Ontario educators in this novel approach to self-directed online learning. More than 500 educators were registered in #notabookstudy activity and 35 educators answered the call to provide feedback to the team (which is a normal turnout for online surveys). Despite being satisfied with this experience and providing some suggestions useful for planning the next #notabookstudy (e.g., shortening the activity to a month or two; trimming the number of online features and concentrating on the most efficient ones), there was some evidence of success in changing practice since beginning #notabookstudy. The teachers mentioned that that they will concentrate more on assessing the process than the product, making better connections between their lessons, and using models and landscapes more. Math leads wrote about importance of intentional design of the math questions and investigations that would spark students' interest, several P/VPs wrote about the connection of this #notabookstudy to their Board's focus, and several Central Board Staff members mentioned that they will bring this format of learning to their board. One of them wrote:

> *This project opened my eyes to the future of learning and PD! The various avenues for high quality personalized learning are areas I will integrate into my role for sure. The math reading and content was also great learning and will assist me as I support teachers in all subjects and grades.*

There was also evidence that respondents became more networked educators. While not all developed many out-of-their-board connections, the connections within their boards were certainly enhanced.

Behind the scenes my colleagues and I had various conversations after the weekly podcasts which extended my understanding of the mathematics that we were learning about but also provided a spark for us to maintain momentum for our learning and planning. (P/VP)

Remaining Challenges

The MLN educators share concerns of many educators in Ontario who see that the most difficult part of their role is to get others on board. One ML²N member talked about "pockets of resistance, and [how for her] it's always about removing the barrier." This may be particularly relevant for educators in administrative roles, as one GECDSB school administrator wrote, "My role is to shift the culture within my school so that all teachers embrace new math learning." On that note, some P/VPs wrote that they need to "learn more about how to question the thinking of negative people" and "to work on changing the math mindset of some staff," while one math lead asked for "assistance in getting the entire staff involved and on-board with math learning in upcoming years."

While we will continue to monitor possible changes in educators' attitudes and confidence in leading mathematics learning, we are reminded of advice that Fennel, Kobett and Wray (2013) gave to elementary school math leaders: (a) consider the needs of colleagues as adult learners and (b) take the time to get to know and develop rapport with colleagues. In particular, consider:

- Finding a way to meet with colleagues individually and informally;
- Finding out the content, pedagogical, and interpersonal needs of colleagues;
- Demonstrating respect for colleagues;
- Being mindful of their time, curriculum stressors, personal lives, and so on;
- Using the problem-centered approach that works best with adult learners;
- Appealing to colleagues by using internal motivation;
- Gauging how colleagues work with children and how their relationships and attention to child needs relate to how they interact with adults;
- Reasoning for why something may be relevant for them into PD planning; and
- Providing lead-time and an opportunity to discuss upcoming PD sessions.

Other suggested implementation difficulties mentioned in surveys and interviews relate to monitoring the system as well as analyzing, managing, and sharing the collected data.

Conclusions

This report presents selected findings from the research done by the ML CoP member organizations. It is important to note that all of our members were at a different place when our CoP was formed. While the MLN was approaching the end of its first year, the ML²N and the NW ML²N were just starting. The GECDSB's Math Task Force was working intensely for a year already, and a PLC team from the HWDSB just received funding for their inquiry. As we have finished with our short, but productive year, we are very optimistic about what waits for us next. Educators' response to professional learning organized by our member organizations is extremely positive, and we see the value of being connected. Here are some final thoughts.

Professional networks are important for the development of leaders, because they: (a) provide opportunities for social connections; (b) encourage system-wide thinking; and (c) inform practice.

From the research done at GECDSB, it became clear that all educators require support in developing mathematics content and pedagogy. Specifically, the level of content, pedagogy, and leadership knowledge of administrators, MLTs and central office staff differs. For example, the content knowledge of an administrator is different than that of a central office mathematics consultant or a school-based math lead.

Based on the GECDSB experience, mathematics leadership involves the following aspects:

School Context: The environment of the school is the setting in which the learning takes place. Therefore the context needs to be considered by leaders, as leaders familiar with the context are able to more quickly, easily, efficiently lead professional change. Context is also about an understanding that the place where we want to see impact is the classroom. It is the student. Because this is true, the environment for learning must be schools and must be connected to classroom practice.

Collaboration between Educators: Mathematics leadership must be the work of a collective body of educators—each with unique skills, but all having a common vision. The immensity of this work in mathematics requires a team approach, thus allowing leaders to emerge when they are needed and best suited.

Classroom Learning: Mathematics leaders must be connected to classroom learning. The credibility of these leaders is enhances when they are able to make a connection to their recent experiences. In addition, the nature of the learning is such that only those engaged in mathematics learning on a continuous basis are able to develop a deep understanding and then transfer this knowledge to others.

Pedagogical Content Knowledge: Developing content-pedagogy knowledge is the work of mathematics education leaders. This must first be developed in themselves and then in others.

Intentional Cohesion: Creating interconnections between the roles, duties and definitions of mathematics leaders emerges from collaboration and context. Collaboration in itself is not just about sharing the workload. It is about finding ways to align resources, structures and staff and focusing all of these on a common purpose; then materializing all of these to create cohesion. It is what is needed to move from professional learning to professional change.

It will be useful for other boards to see and reflect on how they could use ideas similar to those explored by the GECDSB, or why they think these would not work for them.

The Board also explored the system and school structures, and processes that support mathematics leadership. This includes, for example, timetabling that allows school-based mathematics leaders to lead, coach, and mentor and support the learning of other teachers.

Our member organizations obviously thoroughly follow the Ontario Ministry of Education (2011) guidance for effective leadership, by for example promoting networking of school leaders at the board and school level (MLN, ML²N example) and school level and classroom level (GECDSB example). Participation in co-learning, co-planning and co-teaching is also happening at different levels in our system and we expect to hear more about how schools capitalize on "supporting parent involvement by helping them understand shifts in the teaching and learning of mathematics" (p. 5). One example of the Canada-wide mathematics learning that connected school and home in learning about Canada through mathematics (and about mathematics through topics related to Canada) is *Canada 150 Challenge* that was spearheaded from one of the GECDSB schools (see the Canada 150 document). We expect many more of such innovations from our educators and students!

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