Mathematics: All Hands on Deck and Now What?

This year, as mathematics nudges its way to the forefront across the province, a definite buzz has emerged. The air is filled with excitement, energy, wonderment, and yes, a little trepidation!

It reminds me of the flurry that is starting to escalate as this year's summer Olympics quickly approach. Like preparing for the Olympics, there is much to do. There is a great deal of collective inquiry to pursue around the constructivist approach, problem solving, content knowledge for teaching, as well as assessment and evaluation. The list can seem rather overwhelming, but like training for the Olympics, this inquiry will take focused collaboration, patience, and time.

The good news is that many educators are taking on the Ministry's challenge of "all hands on deck" in mathematics. In some places, it is like a magnificent explosion illuminating the sky after years of a building crescendo, while in others, it is about gingerly placing a big toe into the muddy waters. Although we are in different places, we are on the journey.

In our various roles, we are frequently asked, "What is the difference that makes the difference and will it help ALL of our students succeed in math?" Just as the heart of the Olympian spirit is captured in BELIEVE slogans, the essence of learning lies in people's beliefs and attitudes towards mathematics. The mention of the word "math" is known for triggering strong emotions, opinions, and vivid memories from past math classes. While some may savour the challenge of solving a quadratic equation, others overtly cringe at the very sight of a fraction. Such feelings dramatically impact beliefs about ability and mathematics.

The importance of positive attitudes and beliefs is strongly supported by the external CILM research carried out by Dr. Cathy Bruce. She highlights four sets of student beliefs around mathematics "which research shows impact student motivation, engagement, effort, persistence and related achievement" (Bruce 20).

1. The student's belief that he or she has the ability to be successful in math, which builds both self-confidence and self-efficacy.

2. The student's belief that math knowledge is not separate from everyday knowledge, and the recognition that mathematics has real-life applications which make school learning meaningful.

3. The student's belief that math ability can change if he or she is willing to exert effort.

4. The student's belief that gender stereotyping, a prevailing female perception that math is a male-generated domain, is a myth (Bruce 20).
Like Olympic athletes who are coached and motivated by trainers, students need support to develop the confidence to succeed in mathematics. "All hands on deck" requires all stakeholders, including educators and parents, to reflect on their perceptions of the four identified beliefs.

This is not easy since beliefs are frequently based on previous personal experiences and many of us have grown up in a time when educational systems emphasized specific procedures, one correct answer, and a right-or-wrong mentality. Forgetting the rules without an adequate understanding of the concepts can leave people in an abandoned state of helplessness, creating feelings of anxiety and failure. Beliefs emerge that "math is too hard," and that "I can't do it!"

Reflecting on our beliefs, however, is not enough. Actions provoke change. A beneficial strategy is to do the math and uncover its mysteries. People who love math, can continue to delve into its infinite investigations. Those who are less comfortable can join a professional learning community like CIL-M, or a math book study group, or just collaboratively pursue a personal curiosity.

Why do we invert and multiply when we divide fractions? How can two negative numbers multiplied together become positive? If my lottery numbers haven't won in a long time, do I have a greater probability of winning? Such inquiries, whether big or small, provoke more genuine understanding and carry the potential to change both attitudes and beliefs.

In the many classrooms where I have been facilitating CIL-M hubs, more positive attitudes are surfacing as teachers, administrators, and students engage in problem solving and become more inquisitive about mathematical concepts. Anxiety is dissipating because the answer is not the most important outcome. Of greater significance is the thinking that goes into solving the problem, the exploration of blind avenues that decidedly become dead ends, the flexibility of being able to switch to a more effective strategy, the reasoning that leads to critical decision making, and the lessons learned that help transform conjectures into generalizations.

These thinking processes allow people to truly matematize, to work through and internalize the mathematics, and adopt it as their own. With genuine conceptual understanding comes confidence, successful experiences, shifts in attitude about ability and more positive beliefs about mathematics. The proof is in the classroom. On more than one occasion, I have actually heard the utterance that, "math is fun!"

More Feedback from CIL-M sessions

1. Math Self Confidence and Self-Efficacy

Teacher: I am feeling more confident in my math class as I really start to understand the curriculum expectations and math in greater depth. As I teach more through problem solving, the kids are more engaged and confident too! We are actually having fun!

Student: Yaa, I can do math. I just need some time to work through problems without people always trying to do it for me. I believe in me and they need to too.
2. Math knowledge is not separate from everyday knowledge

**Student:** I build stuff with my dad all the time so today's problem about surface area of a box was easy. I just took that box apart in my head.

**Superintendent:** As I walked into one of my schools, I was amazed by the math taking place. It had to do with fundraisers, pizza days, elections, reconfiguring the area in a classroom – all things that were actually happening in the school. The context meant something to the students and they were totally engaged.

3. Math ability can change

**Principal:** I am witnessing my teachers and myself becoming stronger in math as we engage in this CIL-M. We have also started a book study around John Van de Walle's work and we are learning by doing the math problems he poses.

**Teacher:** All my life, I have relied on the rules that I was told to follow in school. Now I am understanding the concepts and why the formulas are designed the way they are. Today, my mastery moment was that I discovered the meaning behind the formula for a trapezoid!

**Student:** My mom told me that she was bad at math so I thought I was too. But now that we get to solve cool problems with our friends in class, I know that I can do it! People in my group actually listen to my ideas! (I don't know if my mom feels any different though)

4. Gender stereotyping

**Teacher:** I realized that I was paying more attention to my male students and calling on them to answer than the females. It was my way of getting them to behave and keep them engaged. I now give equal air time to my female students.

**Teacher:** We talk openly in class about the stereotypes around gender and math. They make for lively debates. The bottom line is that ALL of my students feel valued and are willing to take risks as they solve some rather intriguing problems.

Final Feedback from a Literacy Coach

"As an activity for my family Christmas party, I had my whole family, people of all ages, work on this amazing math problem that I solved with my colleagues in a professional learning session. Everyone was curious, engaged, working together to try out several approaches, laughing, and, in the end, feeling a sense of mastery. It was a hit!"

While this may not be your idea of family fun, it does demonstrate how one individual’s shift in attitude towards mathematics became infectious. She believed that all family members, regardless of age or experience, could be mathematicians, engaged them in the process, and her belief became a reality.

As we forge ahead on this math journey, there will be gains, setbacks, and challenges, much like the Olympians experience as they diligently and persistently train for four or more years. For them, it is not just about the event, but the energy, discipline, and focus that allow them to be the best they can be, before, during, and after the Olympic experience.

Ultimately they must believe in themselves. By believing in ourselves, one another, and our students, we can collectively nurture and develop positive attitudes around mathematics which will give us the patience and tenacity to proceed and succeed!