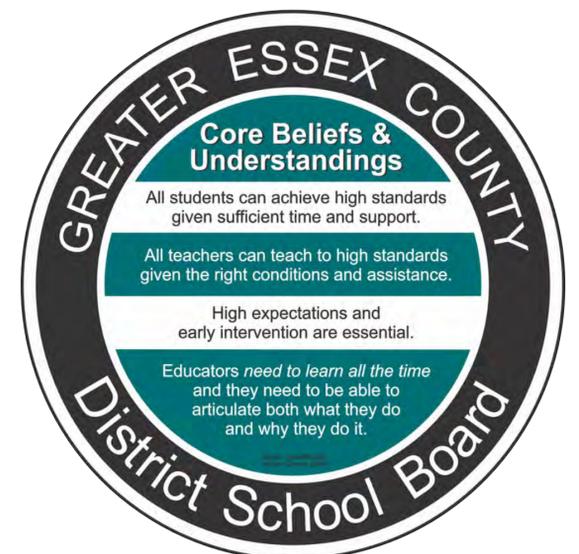


GREATER ESSEX COUNTY DISTRICT SCHOOL BOARD

Implementing Change In Mathematics Pedagogy

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

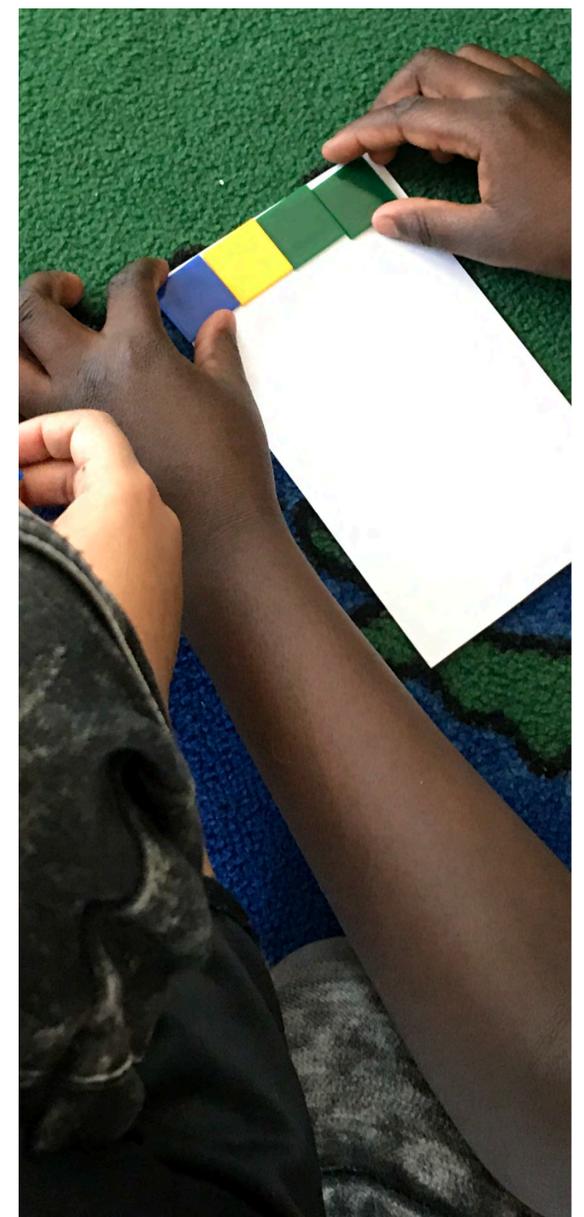


“The Greater Essex County District School Board provides mathematics education that engages and empowers students through collaboration, communication, inquiry, critical thinking, and problem-solving, to support each student’s learning and nurture a positive attitude towards mathematics.”

GECD SB, A Vision for Mathematics, 2016

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

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

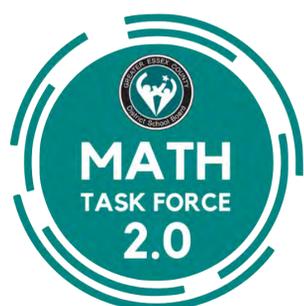


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BUILDING TOMORROW TOGETHER. EVERY LEARNER, EVERY DAY.



“An excellent mathematics program requires effective teaching that engages students in meaningful learning through individual and collaborative experiences that promote their ability to make sense of mathematical ideas and reason mathematically”

(National Council of Teachers of Mathematics- NCTM, 2014)



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

Effective Mathematics Teaching

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

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

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

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

Leading A Change In Instruction

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

The Vision

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

Mathematics Teaching Practices

Establish mathematics goals to focus learning. Effective teaching of mathematics establishes clear goals for the mathematics that students are learning, situates goals within learning progressions, and uses the goals to guide instructional decisions.

Implement tasks that promote reasoning and problem solving. Effective teaching of mathematics engages students in solving and discussing tasks that promote mathematical reasoning and problem solving and allow multiple entry points and varied solution strategies.

Use and connect mathematical representations. Effective teaching of mathematics engages students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem solving.

Facilitate meaningful mathematical discourse. Effective teaching of mathematics facilitates discourse among students to build shared understanding of mathematical ideas by analyzing and comparing student approaches and arguments.

Pose purposeful questions. Effective teaching of mathematics uses purposeful questions to assess and advance students' reasoning and sense making about important mathematical ideas and relationships.

Build procedural fluency from conceptual understanding. Effective teaching of mathematics builds fluency with procedures on a foundation of conceptual understanding so that students, over time, become skillful in using procedures flexibly as they solve contextual and mathematical problems.

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

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

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

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

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

Students' perception of themselves as learners of mathematics is directly tied to their experiences. Developing a productive disposition toward mathematics requires that students

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

Implementation and Change

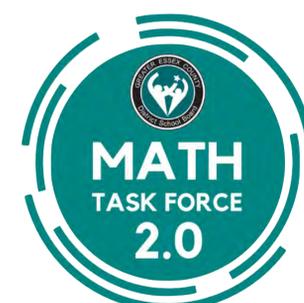
"Change is a process, it is not an event" is the opening subtitle of Gene Hall and Shirley Hord's first principle of change (2006). Our work over the last few years in the GECDsB suggests that there are common themes to the implementation

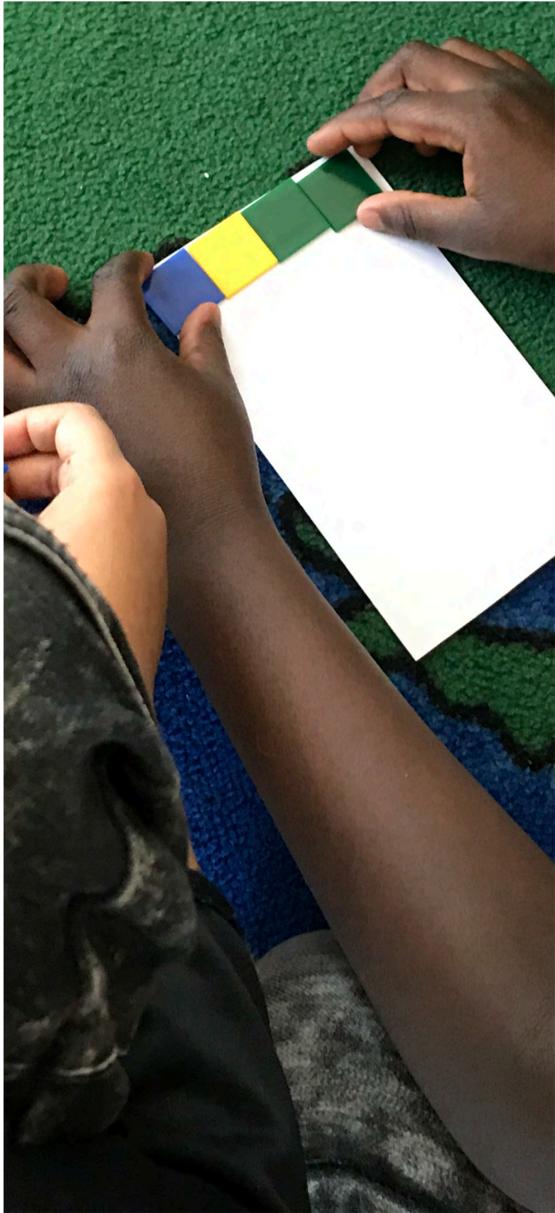
"effective teaching of mathematics engages students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem solving."

(NCTM, 2014 p. 10)

"dominant cultural beliefs about the teaching and learning of mathematics continue to be obstacles to consistent implementation of effective teaching and learning in mathematics classrooms"

(Handal 2003; Philipp 2007)





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

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

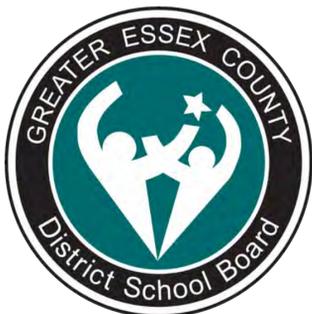
Implementation of effective practice happens through professional learning and improvements in educators' content-pedagogy. Change happens through learning. It does not occur in one sweeping memo, an impassioned speech or a well-written paper. Change happens through the collective efforts of educators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

Change is something that leaders know and understand. The daily work of leaders is knowing when to nudge and when to pull back. Leaders leverage

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

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

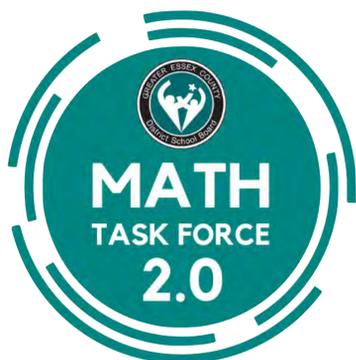
There is no way forward that does not include challenge. As a young, budding mathematician recently stated "I love a good problem. It is prickly and tricky and takes all of my focus. A good problem is a problem worth solving. You need perseverance, creativity, collaboration, and a great teacher." Fortunately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



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