GHSD NUMERACY FRAMEWORK (K-12)

Revised January 2018

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The purpose of this framework is to strengthen instructional practice to enhance learning and achievement for all students in numeracy as part of Powerful Learning.

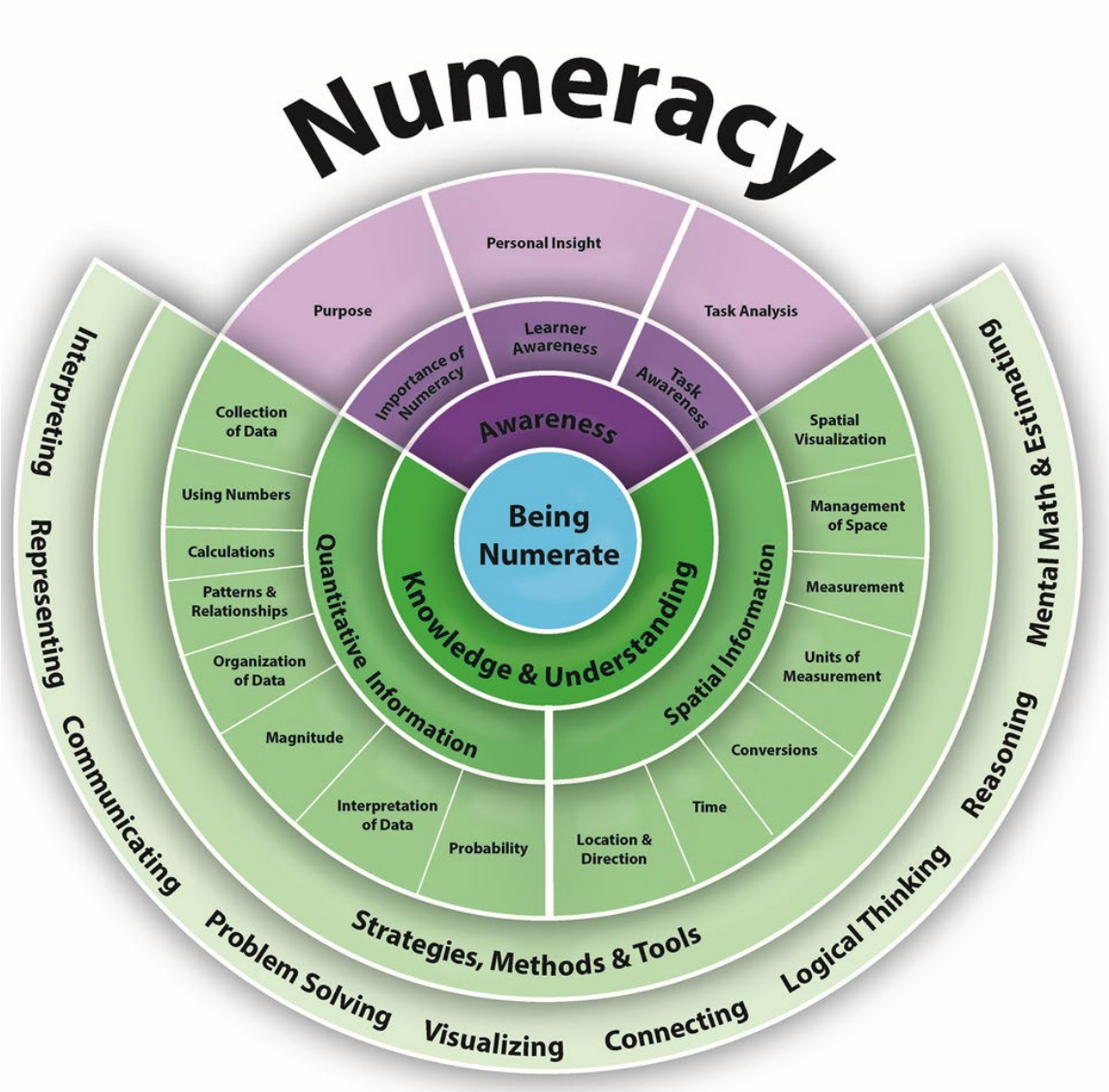
The purpose of the framework:

- Create a shared understanding of numeracy and its components
- Support teacher pedagogy by guiding in depth conversations and enhancing instructional practices in numeracy
- Create a shared understanding of research based approaches to numeracy instruction

Research indicates that initiatives are most effective with a division-wide focus and implementation. A small number of clearly defined goals tied to student achievement which are relentlessly pursued can be expected to result in the greatest gains.

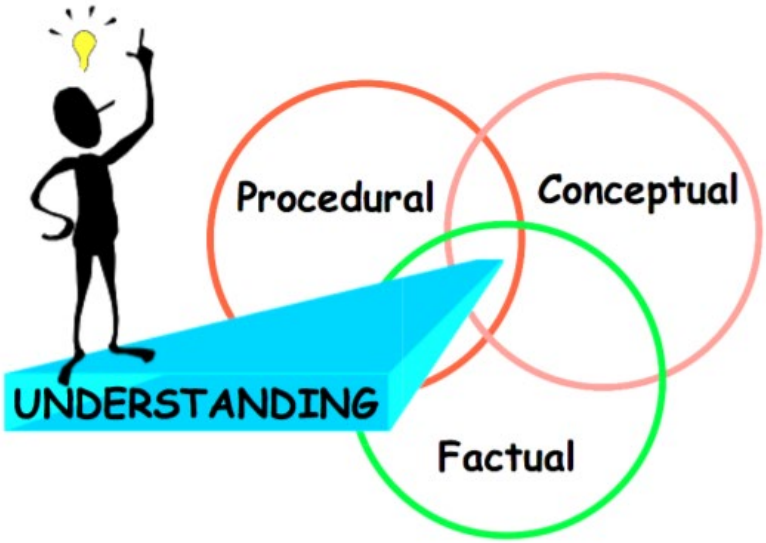
Numeracy Framework Beliefs and Assumptions:

Numeracy is foundational to student learning. Being numerate means going beyond the acquisition of basic skills and solving simple arithmetic problems to being able to acquire, create, connect, understand and communicate information.



Guiding Principles

The National Mathematics Advisory Panel states that learning mathematics requires three types of knowledge:



Factual knowledge and automatic retrieval of basic math facts refers to having ready in memory the answers to a relatively small set of problems of addition, subtraction, multiplication and division.

Procedural knowledge refers to a sequence of steps by which frequently encountered problems may be solved.

Conceptual knowledge is an understanding of meaning. Students must understand the "why" of a mathematical concept.

The following statements describe the assumptions which guide teachers in the implementation of numeracy instruction in GHSD:

- Mathematics is the science of pattern and order. Instruction in mathematics discovers the big ideas and mathematical constructs used to see, organize and interpret the world.
- Students explore and make sense of the world around them by being provided opportunities to understand where math lives in the real world.
- Through mathematics students will be able to discover patterns, explain real world phenomenon and solve real world problems.
- Understanding and being able to manipulate patterns is central to achieving a deep level of understanding in mathematics.
- Finding, exploring and making sense of patterns and visualization of mathematic is foundational to becoming a numerate citizen.
- Mathematical learning is enhanced when students connect new learning with previous knowledge and understanding.
- Students are encouraged to make connections and understand the mathematics they are exploring through worthwhile tasks which invite students to take risks, share and defend mathematical ideas.
- Students use a variety of representations to demonstrate their understanding of mathematical concepts and communicate this understanding through academic vocabulary.
- The mastery of number facts occurs when students understand and recall facts in order to apply their knowledge to solve more complex computations. In addition, students need to be able to apply number facts to critically solve problems, reason and justify answers. Depth of understanding is valued more than speed.

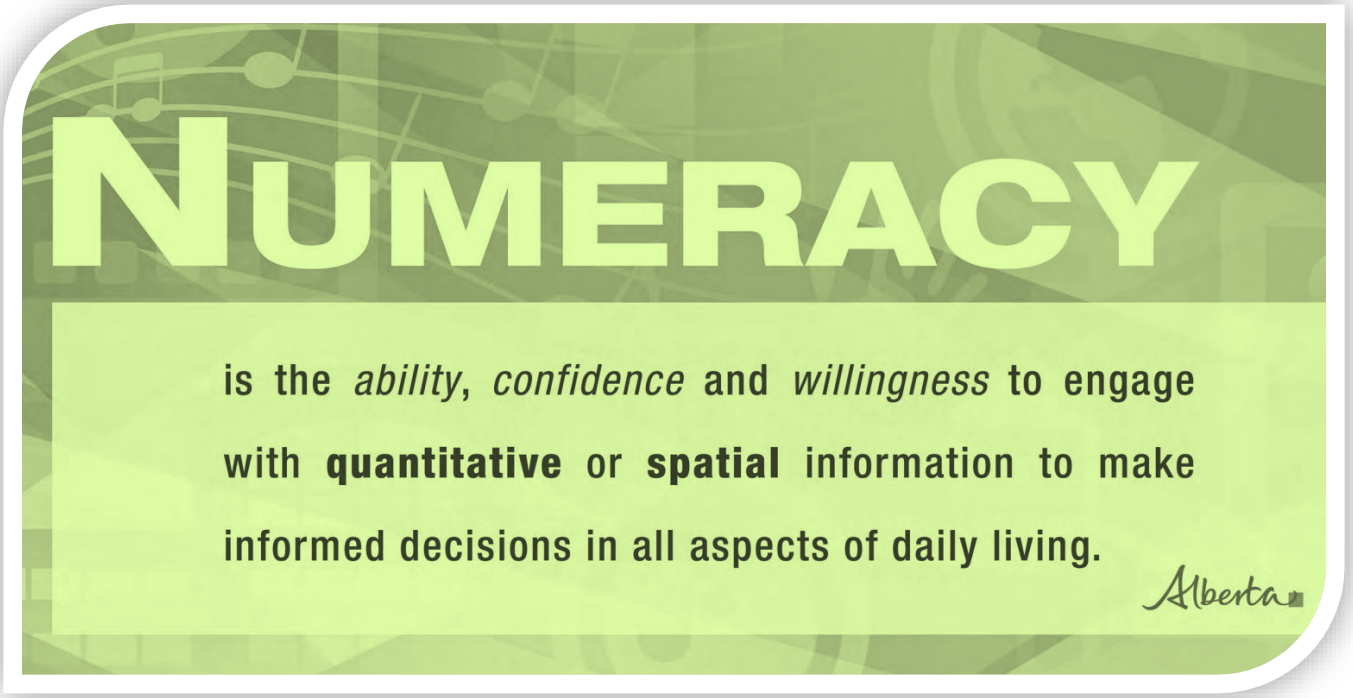
Definition of Numeracy:

The GHSD Numeracy Framework defines numeracy as it is defined by Alberta Education (2015):

"Numeracy is the ability, confidence and willingness to engage with **quantitative** or **spatial** information to make informed decisions in all aspects of daily living" (Alberta Education, 2015)

Quantitative Information can be measured and expressed as an amount. It includes numbers, patterns, statistics and probability
Spatial Information is the physical location of objects or people or the relationship between objects or people. It includes measures, location, direction, shape and space (Alberta Education Numeracy Fact Sheet May 2016).

Golden Hills School Division strives to engage all learners with varied abilities and unique experiences to reach a deep understanding of numeracy across all curriculum areas. A deep understanding of math is based on a strong



foundation that includes mastery of basic facts/mental mathematics strategies as outlined in the Alberta Mathematics Program of Studies.

In order to improve achievement, it is vital that we increase the math confidence levels in our students. This framework is designed to help teachers understand the importance of determining the entry level of each student and to facilitate student success through carefully created tasks and activities. To accomplish this, the student and teacher work together setting math goals/targets and continuously reflect on student progress as they move towards these goals and mastery of numeracy concepts.

Golden Hills Numeracy Framework identifies best practices and resources to guide teachers in the implementation of Alberta Mathematics Kindergarten to Grade 9 Program of Studies. The framework was developed with careful consideration and integration of the Golden Hills Powerful Learning document as well as the Inspiring Education document, which states all students will be inspired to achieve success as engaged thinkers and ethical citizens with an entrepreneurial spirit (Inspiring Education – A Dialogue with Albertans, 2010).

"Teachers are key figures in changing the way in which mathematics is taught and learned in schools. Their subject matter and pedagogical knowledge are critical factors in the teaching of mathematics for understanding. The effective teacher of mathematics has a thorough and deep understanding of the subject matter to be taught, how

Classroom Environments to Foster Deep Understanding

An engaged “numeracy” learning environment fosters creativity, communication, citizenship, critical thinking and connecting and collaborating..

Make connections to their background and experiences.

To create an engaged classroom, THE TEACHER intensionally establishes a safe and dynamic environment that:

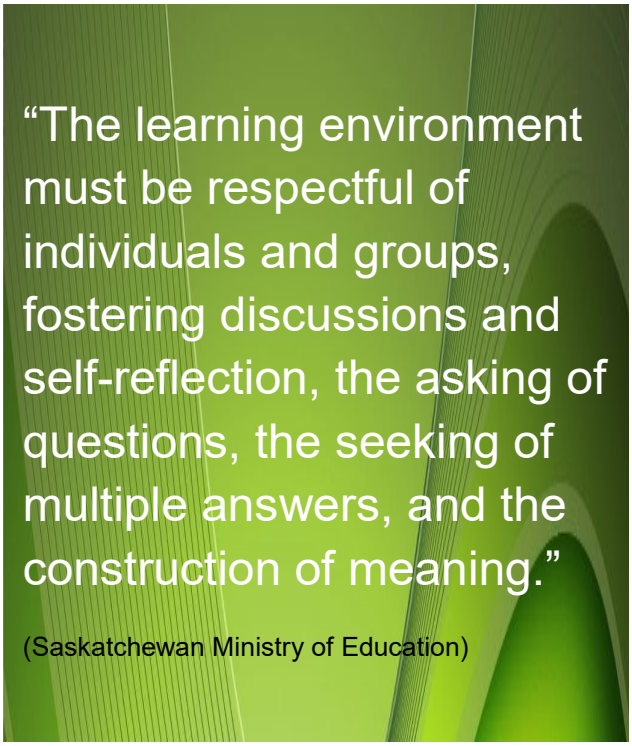
- encourages persistent effort, engages students in a *productive struggle* and helps students embrace challenge.
- supports risk taking.
- links foundational math with open-ended problem solving to develop critical thinking skills that extend beyond the classroom.
- provides opportunities for the formation of real world connections.
- promotes student collaboration, open reflection and discussion about concepts and learning.
- creates a community of thinkers.
- develops competencies in the application of mathematics.
- provides timely and specific feedback that moves the learning forward.
- fosters a growth mindset where students see effort as a path to mastery.

“There will always be differences between students, but we don’t need to exaggerate or highlight them by setting up unnecessary hierarchies. By using materials and methods that minimize differences, teachers can cover more of the curriculum and can narrow or close the wide gap in student performance that exists in most classrooms”

Retrieved from http://www.jumpmath.org/jump/en/Philosophy

Role of THE STUDENT:

- share ideas in an environment of acceptance, where it is safe to take risks.
- assume a growth mindset: a belief that growth and learning require effort.
- realize that mistakes provide opportunities for learning.
- demonstrate persistence and embrace challenge when solving complex problems.
- make connections between different strategies, concepts, and contexts to solve a particular problem.
- be strategic in selecting best suited strategies.
- monitor and self-reflect on the process - catching and adjusting errors along the way.
- use critical thinking skills and strategies that extend beyond the classroom.
- demonstrate a deep understanding of the connections mathematics plays in the real world.
- reflect on and communicate learning in realistic and meaningful contexts.
- demonstrate confidence in numeracy.
- engage actively by communicating through the use of mathematical language.



Components of a Balanced Numeracy Program

Foundational Skills

Number relationships (number sense) provide the foundation for strategies that help students remember basic facts. Alberta Education (2014, p. 2) states, “The mathematics program of studies expects students to master their number facts. Mastery of number facts occurs when students **understand and recall** facts.

This allows students to apply their knowledge to different and more complex computations and to be flexible in their thinking."

When implementing the "Mathematics program of studies", Golden Hills School Division recognizes the need of ensuring students master foundational skills (which includes basic facts) as well as, students learning by "doing" and being provided high-quality tasks that allow them to figure out their own strategies and solutions to problems. Mastery of basic facts enables quick and accurate recall, which is foundational to being able to solve complex computations and problems.

Understanding early number concepts and number relationships is essential when learning basic facts. For example, the strategy of knowing how numbers are related to 5 and 10 helps students to master the facts. Strategies outlined in Van de Walle's work and programs such as "*Jump Math"* and "*Power of Ten*" help students to recognize patterns and understand "number relationships". Subitizing (being able to see how many there are at a glance without counting) when directly taught and practiced is fundamental to developing students concept of number. Teaching strategies in math enables students to use known facts and relationships to solve unknown facts. Mastery occurs best when students understand number concepts and relationships rather than rote drill of facts. "Students who encounter difficulty with mastering basic facts typically do not lack drill instead it is the failure to develop or connect concepts and relationships that is the barrier" (Van De Walle et al., 2013, p.186). The pressure of timed tests for fact mastery distracts students, creates anxiety and results in students abandoning reasoning required for completing the basic fact. Quick recall and mastery can be obtained when students are ready, in other words once they have acquired a collection of reasoning strategies that they can apply when needed.

Observing students when they encounter an unknown fact enables a teacher to analyze current strategies used by the student and helps to provide the next steps in learning.

Problem Solving/Critical Thinking

Problem solving encourages students to look for relationships, analyze patterns, employ trial and error methods and justify and evaluate results (Van de Walle, J. A. & Lovin, L. H., 2006). Students are asked to apply foundational math skills to solve authentic problems and to be creative and flexible in their thinking. Problem solving skills need to be taught and practiced. "Learning through problem solving should be the focus of mathematics at all grade levels" (Alberta Education, 2007, p. 6).

Academic Vocabulary

Academic vocabulary instruction involves identifying and explicitly teaching the words that students must know in order to establish a foundation to construct knowledge. "Teaching specific terms in a specific way is probably the strongest action a teacher can take to ensure that students have the academic background knowledge that need to understand the content they will encounter in school" (Marzano & Pickering, 2005, p.1).

Formative Assessment

Formative assessment can be seen as an on-going process that relies on several measures over time. It is viewed as a process rather than a singular event (Bennett, 2011). Formative assessments use information from the judgment of student work and performance to improve student achievement (Sadler, 1989). Students are provided with feedback as to how successfully a task has been completed or is being completed. They use this feedback to improve upon their achievement. Information collected through the use of formative assessment is used to further student learning (Ayala, 2005). Teachers create instruction based on evidence gathered through formative uses of assessment. These formative interactions are designed to encourage thought on the student's part (Black & William, 2009). Teachers use information from these interactions in order to make decisions surrounding the curriculum and the direction of learning. They determine whether to move forward, how to move forward and where to encourage student focus. This view focuses on the process of developing and changing instruction to match student needs.

Numeracy Assessment

Numeracy assessments provide teachers with information about the learner's progress in acquiring numeracy skills and help to determine next steps. GHSD recognizes that observing a student engaged in numeracy activities, enables teachers to understand the strategies used by the students, the struggles they are encountering and how to provide feedback to enhance their understanding of numeracy.

A common set of numeracy assessments in GHSD will enable teachers to determine the progress of their students and track this over time. It also enables teachers and administrators to determine the specific numeracy skills gained during a set period of time. Through common assessment students who are "At Risk" can be identified and a plan developed for how to meet the needs of all students. By monitoring student progress, insights can be gained about what approaches and strategies might have the greatest impact on learning.

GHSD teachers employ assessment "for learning" (using information to guide instruction and improve student learning) and assessment "of" learning (summarizing and making judgments about the quality of learning) to improve numeracy skills. The importance of sharing learning targets and co-constructing what success looks likes for students is identified and practiced. Teachers gather, analyze and interpret evidence of literacy learning over time, using a variety of tasks, assessment strategies and documentation.

Numeracy Framework Implementation Plan

The Numeracy Framework implementation plan was developed based upon the consolidated feedback from teachers obtained through interviews, as well as feedback from administrators. Your input is appreciated and continued feedback is encouraged as we begin implementation of the Numeracy Framework in 2015-2016.

Assessment Plan Grades 1- 6

Assessment	Implementation	Timeline for Implementation
Diagnostic/Formative Assessment Grades 1-6* students will be administered a common formative assessment each year in the fall (September)	This will be used to provide information to teachers so they can plan learning activities for the year and identify at risk learners Examine a variety of math diagnostic/formative assessment tools for Grades 1-6* If required, teachers can request instructional coaches to set up school wide assessment on StudentsAchieve. Videos and step by step sheets will be available.	**>Fall 2015:** Grades 4-6 teachers will pilot a formative assessment and compile results in StudentsAchieve (School Wide Assessment tab) If developed, Grades 1* will pilot as well **>Fall 2016:** Grades 2-6* teachers will and compile results in Dossier (Attach to PowerSchool)
Common Unit Exams	Grade level teams have used collaborative days to develop common unit exams	**> 2015-2016:** Some grades will pilot common summative unit exams
Summative Assessment Grade 1-6* students will be administered a common summative math assessment each year in the Spring (June)	This will be used to show student progress.	**>Spring 2016:** Grades 1-5* Teachers will explore a common summative assessment tool and compile results in StudentsAchieve (School Wide Assessment tab) **> Spring 2017:** Grades 1-5 Some teachers will pilot a summative math assessment in June

***Consideration will be given to students already writing an SLA and/or a PAT**

> Information will be gathered throughout the course of the year. This data and information will be reviewed annually in order to determine the impact of the plan and identify next steps. The goal will be to look for patterns and ways to support the numeracy work in GHSD.

There are a variety of resources and approaches to teaching numeracy. The following have supporting research that demonstrates a high impact on student learning. (For a more in-depth description of the recommended approaches/programs please refer to the numeracy framework)

Recommend Resources/Approaches Summary:

Academic Vocabulary:
Academic vocabulary instruction involves identifying and explicitly teaching the words that students must know in order to establish a foundation to construct knowledge.

Jump Math:
This program delivers the mathematical curriculum through the method of "guided discovery." In JUMP lessons, students explore and discover mathematical concepts independently in manageable steps, while the teacher provides sufficient guidance, examples, feedback and scaffolding for all students to meet their full potential.

Power of Ten:
This **System** is a set of visual tools (ten-frame cards, place value cards and ten-frame egg cartons) designed to help students develop the fundamental underpinnings of number sense and is based on the premise that over eighty percent of learning is visual.

Other Resources:
A Numeracy course has been created on the Golden Hills Learning Commons to help support teachers and students in the area of numeracy. http://lc.myghsd.ca/course/view.php?id=545&section=0

Also see the sections in the numeracy framework on recommend:

- **Web-based math programs**
- **Supplementary math resources**

Golden Hills School Division will support and provide professional development opportunities in foundational skills (such as basic math facts), academic vocabulary, problem solving/ critical thinking, academic vocabulary, Jump Math and Power of Ten.

Recommended Numeracy Approaches/Programs

There are a variety of resources and approaches to teaching numeracy. The following have supporting research that demonstrates a high impact on student learning.

Intentional/Explicit teaching of Academic Vocabulary:

Research:
Marzano and Pickering (2005), reported that when students have general knowledge of the terms that are important to content taught in school, achievement is significantly improved. One of the most crucial advantages that teachers can provide, particularly for students who do not come from academically advantaged backgrounds, is systematic instruction in important academic terms.

Overview / Implementation:
Academic vocabulary instruction involves identifying and explicitly teaching the words that students must know in order to establish a foundation to construct knowledge.

Explicitly teaching academic vocabulary involves 6 basic steps. Attending to all steps ensures best results.
Step 1. Introduction: Provide a description, explanation and or examples of the new term.
Step 2. Restate: Students explain or describe the term in their own words. An academic notebook is suggested to keep track of the terms.
Step 3. Draw & Self Assess: Students draw a picture, symbol or graphic to represent the meaning of the term. Students self-assess their level of understanding of the term.
Step 4. Activities: Provide activities to engage students as they work to remember the terms. Ex: antonyms/synonyms, compare/contrast, morphology.
Step 5: Talk: Discussing the terms with a peer allows for misunderstandings to present themselves and knowledge to deepen.
Step 6: Games: An engaging way to learn the terms. Frequent use of the terms helps transfer the terms into long memory.

JUMP Math:

Research:

JUMP Math is recommended by the Canadian Language and Literacy Research Network as a program that "offers educators... complete and balanced materials as well as training to help teachers reach all students".

- *J. Bisanz et al. (2010) Foundations for Numeracy: An Evidence-based Toolkit for the Effective Mathematics Teacher. Canadian Child Care Federation and Canadian Language and Literacy Research Network, p. 44.*

In 2011, L. Alfieri et al. conducted a meta analysis of 164 studies of discovery-based learning and concluded that "Unassisted discovery does not benefit learners, whereas feedback, worked examples, scaffolding and explicit instruction do." The authors recommend "enhanced discovery" (discovery with the instructional supports mentioned above) as the most effective approach to instruction in mathematics.

- *Alfieri, L., et al. (2011) Does Discovery Based Instruction Enhance Learning? Journal of Educational Psychology, Vol. 103, Issue 1, p 1-18.*
- *See also the references below for evidence that discovery needs to be balanced with rigorous guidance: Anderson (2000), Gobet (2005), Van Merrienboer (2005), Ross (2006), Kirshner (2006).*

Overview / Implementation:

The JUMP Math program delivers the mathematical curriculum through the method of "guided discovery." In JUMP lessons, students explore and discover mathematical concepts independently in manageable steps, while the teacher provides sufficient guidance, examples, feedback and scaffolding for all students to meet their full potential.

JUMP lesson plans and materials allow teachers to differentiate instruction by providing extra practice, scaffolding and continuous assessment for students who need it, and more advanced work for students who finish their work early. But while instruction is differentiated, the significant majority of students are expected to meet the same standards.

http://jumpmath.org/jump/en/

Power of Ten:

Research:

New studies suggest that subitizing – learning to identify numbers without counting – is crucial to the development of number sense and basic fact acquisition. Power of Ten cards teach children ages 3-11 to subitize as they play.

Overview/Implementation:

The **Power of Ten System** is a set of visual tools (ten-frame cards, place value cards and ten-frame egg cartons) designed to help students develop the fundamental underpinnings of number sense and is based on the premise that over eighty percent of learning is visual (unless the student is severely visually disabled).

Spring 2015-train internal experts (coaches)

http://poweroften.ca/

Recommended Web-based Math Programs:

Program	Overview / Implementation
Mathletics	A web-based resource that is powerful, targeted and most importantly relevant to all students. Mathletics includes well over 1200 individual adaptive practice activities and eBooks for all grades. Our team of education publishers have created a course that follows the Alberta curriculum. This has potential for implementation through assistive technology. http://www.mathletics.ca/
Math IXL	Math IXL is online, outcome-based, math practice that addresses Junior Kindergarten to Grade 12 skills. Can be purchased by individual schools/teachers. http://ca.ixl.com/math/
Prodigy	Prodigy is a web-based game that is engaging and adapts to each students learning pace. This program is free to sign up. Exclusive member can pay for added features https://www.prodigygame.com/Canada/

Supplementary Math Resources:

***All are available for loan through IMC.**

Resource	Overview / Implementation
About Teaching Mathematics (K-8)	Marilyn Burns A teacher resource book on developing children's ability to think and reason mathematically and help them learn the concept and skills to do so.
Big Ideas (K-12)	Marian Small This resource reminds teachers the Big Ideas in math need to drive our instruction.
Teaching Student-Centered Mathematics K-3, 3-5 & 5-8	John A. Van de Walle & LouAnn H. Lovin This resource focuses on a student-centered, problem-based approach that helps students develop confidence and a deeper understanding of mathematics.
From Patterns to Algebra	Drs. Bruce and Beatty This resource has students work through tasks starting with simple patterns and developing linear relations and graphs. K-10
Math & Literature (Division 1)	Marilyn Burns (Division 1) There are a number of these books in the IMC on the different math stands. Each book has suggested activities and samples of student work. This resource also accompanied by the literature book.
Writing in Math Class Gr. 2-8	Marilyn Burns This resource explains why students should write in math class, the types of writing and tips and suggestions.
50 Problem Solving Lesson Gr.1-6	Marilyn Burns This resource has 50 math problem solving lessons from all of the math stands. It also includes student examples and blackline masters.

*Future development: Links to teacher demonstration videos, parent and teacher supporting materials

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