NUMERACY FRAMEWORK

Kindergarten to Grade 12 (2021)

Purpose

This Framework will help strengthen instructional practice to enhance learning and achievement for all students in numeracy as part of Powerful Learning:

- To create a shared understanding of numeracy and its components
- To support teacher pedagogy by guiding in depth conversations and enhancing instructional practices in numeracy.
- To build a shared understanding of research-based approaches to numeracy instruction.
- Our goal is to help students understand math instead of just doing math.

Definition of Numeracy

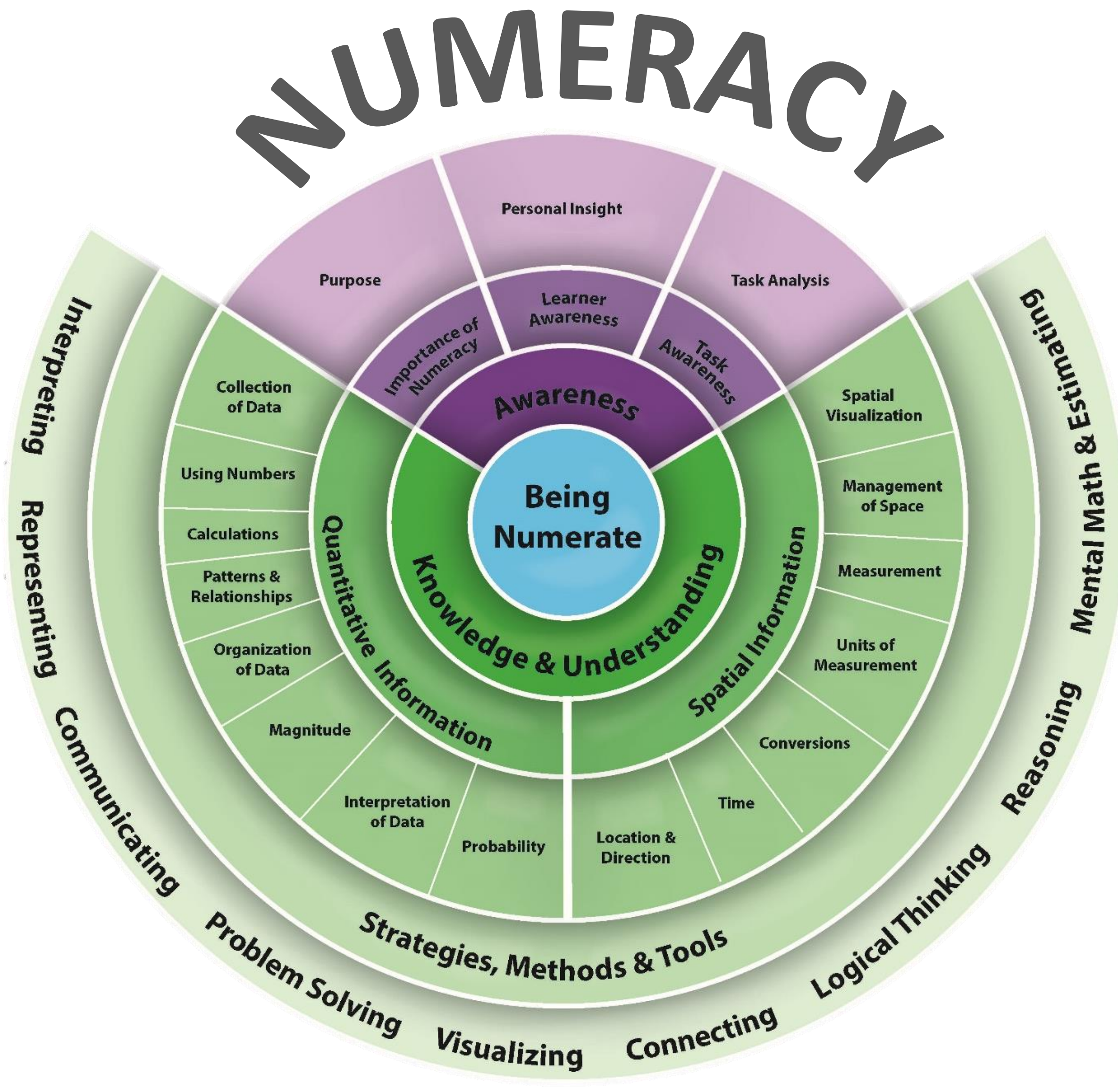
The Golden Hills Numeracy Framework defines numeracy as it is defined by Alberta Education:

“Numeracy is the ability, confidence and willingness to engage with quantitative or spatial information to make informed decisions in all aspects of daily living.”

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 2017).

Numeracy is foundational to student learning. Being numerate means going beyond the acquisition of basic skills and solving simple arithmetic problems to achieve deep understanding. Students demonstrate being numerate by acquiring, creating, connecting, transferring, and communicating information.

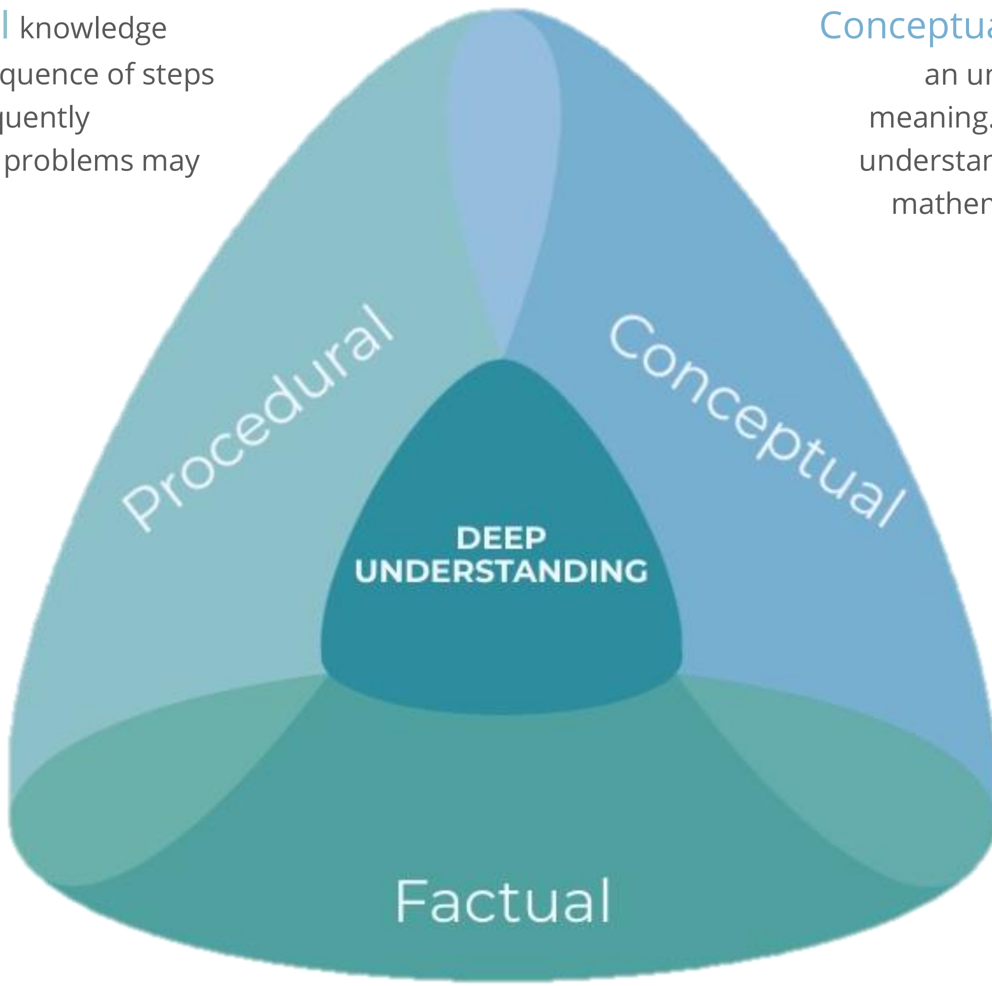


Math Knowledge

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

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.



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.

To create fluency, students need accuracy, efficiency, and flexibility.

Overarching Statements Which Guide Teachers in the Implementation of Numeracy Instruction

- Mathematics is the science of pattern and order. Instruction in mathematics discovers the big ideas and mathematical constructs to see, organize, and interpret the world.
- Discovering, exploring, understanding, and manipulating patterns are fundamental to achieving a deep understanding of mathematics.
- Spatial reasoning is crucial in the development of mathematical thinking and plays a fundamental role in supporting numeracy.
- Flexibility and fluency of math facts is important for students to efficiently solve complex mathematics.
- Communication is key to building mathematical understanding. Students should challenge assumptions, ask questions, share, and defend mathematical ideas.
- Mathematical learning is enhanced when students connect new learning with previous knowledge and understanding.

"One of the very best things we can do for our students is to help them develop mathematical mindsets, whereby they believe that mathematics is about thinking, sense making, big ideas and connections – not about the memorization of methods"
(Boaler, J. 2016 pg. 47)

Classroom Environments to Foster Deep Understanding

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

To create an engaged classroom of confident learners, ***the teacher*** intentionally establishes a safe and dynamic environment that:

- creates a community of thinkers.
- supports academic risk taking.
- believes everyone can learn math at a high level.
- engages students through powerful questions and discussion to deepen understanding.
- encourages students to pose questions.
- values depth of understanding more than speed.
- encourages persistent effort and engages students in a *productive struggle* to help students embrace challenge, thus fostering a growth mindset.
- values mistakes as learning opportunities.
- 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.
- encourages multiple perspectives and ways of representing mathematics.
- promotes student collaboration, open reflection and discussion about concepts and learning.
- develops competencies in the application of mathematics.
- provides timely and specific feedback that moves the learning forward.
- creates opportunities to explore spatial reasoning.

Teachers foster a sense of wonder and curiosity.

As a learner, the role of ***the student*** is to:

- share ideas, ask questions, and take academic risks.
- assume a growth mindset.
- realize that mistakes provide opportunities for learning.
- demonstrate persistence and embrace challenge.
- make connections between different strategies, subjects, 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.
- develop confidence in numeracy.
- communicate using mathematical language and academic vocabulary.

Developing Automaticity

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 to ensure that students build fluency and flexibility of basic facts. As well, it is essential that students learn by "doing" and being provided high-quality tasks that allow them to figure out their own strategies and solutions to problems. Understanding number relationships and strategies enables students 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 as well as Jo Boaler and Christina Tonevold, helps 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. Fluency and flexibility of number facts 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.

Although learning these facts has traditionally occurred through memorization, increased proficiency occurs when students conceptually understand connections and number relations. In other words, automaticity is achieved through engaging in mathematics conceptually and visually (Boaler, pg. 42) instead of drill and practice which results in students who see each fact in isolation. It is important to provide experiences that allow students to explore, visualize and see the patterns and relationships in number.

Implementation – Assessment Plan

Diagnostic/Formative Assessment

Assessment

Grades 2-6* students will be administered a common formative assessment.

Math Intervention Programming Instrument (MIPI)

Grade 7-10 students will also be able to use.

Implementation

This will be used to provide information to teachers so they can plan learning activities for the year and identify at risk learners.

The MIPI implementation guide can be found on the Learning Commons

https://lc.myghsd.ca/

Timeline for Implementation

**In September Grades 2-6* teachers will administer the MIPI to their class and results will be compiled in Dossier (attached to PowerSchool).

**MIPI will be optional for Grades 7-10 students.

**Consideration will be given to students already writing an SLA, PAT, or diplomas*

***Information will be gathered throughout the year and will be reviewed annually 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.*

Summative Assessment

Assessment

Common Unit Exams

Common yearly summative assessment each year in June.

Implementation

Grade level teams are using collaborative days to develop common unit exams.

Grade level teams are using collaborative days to develop common final assessments.

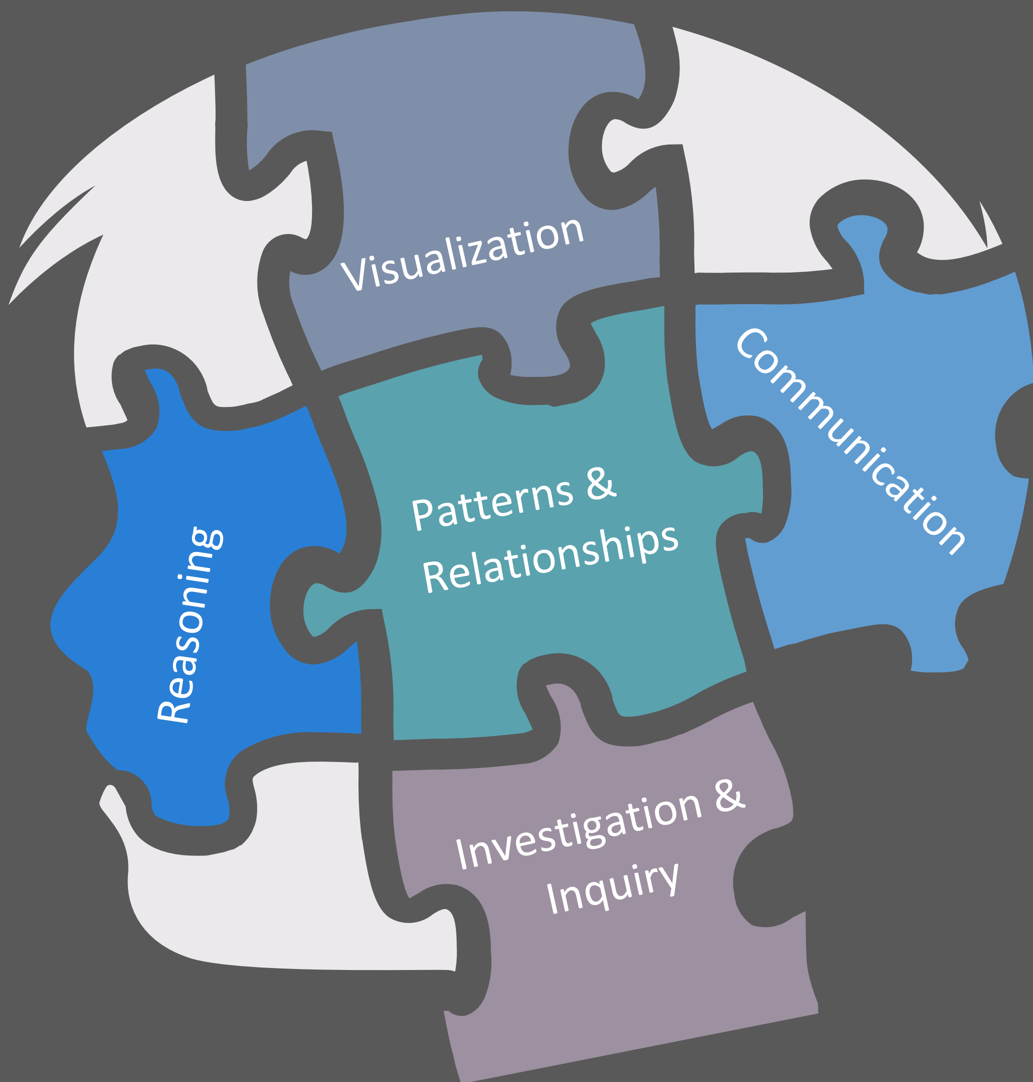
Timeline for Implementation

**Some grades will use common summative unit exams.

**Some grades will use common final summative assessments.

***Information will be gathered throughout the year and will be reviewed annually 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.*

Golden Hills Five Essential Processes



Visualization

Teaching mathematics in a visual way is a powerful tool for learning math. It capitalizes on what the brain does naturally to make meaning and it requires active processing in order to convert information into a visual form. In other words, visualization teaches students to use pictures or visual representations to see mathematical ideas and understand the relationship between numbers and ideas. It facilitates higher-level thinking, mathematical reasoning and helps students to talk about what they understand in math. When students can see the visual representation or pictures, they are able to understand the relationships and ideas more readily. For example, concepts such as multiplication are easier to understand when represented visually through an array.

Visualizing in mathematics is often thought of as drawing pictures or diagrams to solve a problem. However, visualization can also be used to create a model and to plan ahead to solve a math concept.

In the classroom start by asking yourself how you might represent the learning target you are about to teach, in a visual way. Common visualization resources include area models, number talks, graphs, number lines and splats.

Patterns & Relationships

Patterns and relationships are key in making meaningful connections in the world of numeracy. As stated previously in this framework, mathematics is the science of patterns. Making connection and seeing patterns helps consolidate understanding of mathematical concepts.

Both mathematics experts Jo Boaler and John Van de Walle agree there is a set of big ideas in math that are connected to one another. “These connections give mathematics coherence which supports all students making sense, as students draw on what they know about one big idea to learn about another.” Jo Boaler pg. 5. Students need to build a strong understanding of number relationships by gaining fluency through flexibility.

Math is all around us in life and we want students to see the beauty in the patterns and relationships and make connections. We want students to focus on relationships between numbers and to construct a flexible mindset that they can rely on and draw from when working on mathematics. Speed is not the goal, understanding is. We want students to be able to compose and decompose numbers with the patterns and relationships that they have internalized.

We want our students to have the

Reasoning

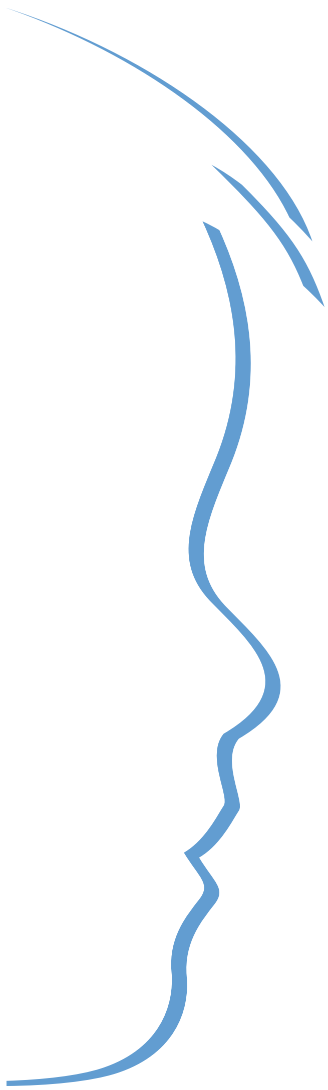
Mathematical reasoning is being able to think critically and make sense of quantities. This happens when students think about numbers and operations in meaningful ways. In order for students to be able to reason in math (abstractly and quantitatively) they first need a strong foundation in number, operations and base ten. This strong number sense can develop when students are allowed to use their own approaches to solve problems. When students create meaningful representations in mathematics, it helps them to see the relationships between the quantities.

Encourage students to reflect on solutions to problems and determine whether they make sense. To do this, students learn to slow down from quickly answering questions to thinking and wrestling with concepts. One way to increase mathematical reasoning is to ask students to explain and justify their answers. When students explain and justify their mathematical reasoning their reasoning expands their understanding. Another way is to give students an answer and have them think about a possible equation, in order to increase reasoning and fluency.

Reasoning is required when we ask students to construct viable arguments and use critical thinking, forming judgments based upon a criteria. It is helpful to first model this process and make the thinking or reasoning visible for students.

In order for students to extend strategies and apply them in new situations, students need to be able to reason “why” and “how” so they can adapt the strategy to the problem they are trying to solve.

Communication



Communicating mathematical ideas depends upon understanding. Research suggests that helping students to put their mathematical thinking into words engages more students and boasts achievement (Robert Berry, 2020). A well-designed math conversation can make it easier for all students to participate. It happens when teachers ask students to explain and share their thinking either verbally, through models or through math journals. Being able to explain and justify mathematical ideas has been shown to expand understanding. Students can use manipulatives or visual representations to describe, explain and demonstrate what they know.

Help students to see the interconnection between mathematical ideas and then help them to talk about the connections. Also, look for ways that students can connect the new learning with what they already know. In a classroom that fosters thinking and mathematical conversations, you will hear "Can you tell me how you solved that?" or "Tell me about your strategy." Provide students with many opportunities to talk about mathematics and communicate understanding. Research shows that "when students are expected to describe their strategies in detail with the teacher and with each other, they demonstrate higher mathematical achievement" Webb et al. 2008 and 21009 as cited in Children's Mathematics, Carpenter et al. 2015 pg. 140.

Investigation & Inquiry

Mathematical investigations encourage thinking and happens when students are given rich and open-ended tasks, selected to help students to arrive at a pre-determined mathematical understanding. Investigations can be used to encourage curiosity, debate and communication. It also happens when teachers pose questions, or a problem and students explore or investigate the processes and concepts involved. This assumes that as a teacher you expect that more than one process can lead to the right answer. Adding mathematical inquiry, investigation and problem solving to a math lesson is a useful tool for teaching mathematics and is in contrast to the application of rehearsed algorithms.

Effective investigations occur when students are taught how to conduct investigations, how to ask questions, how to observe and communicate findings. Students talk about what they are finding in order to clarify their thinking.

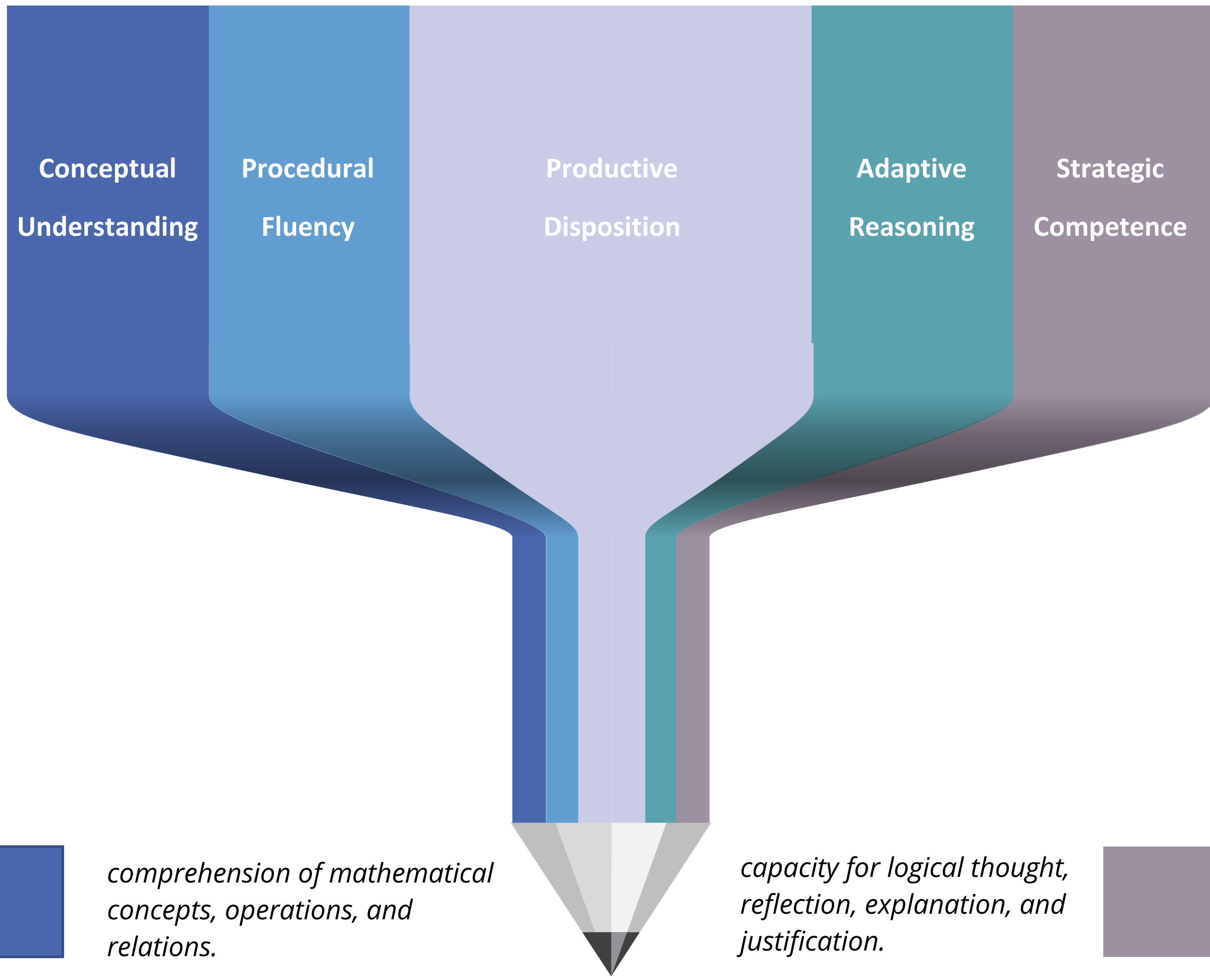
The following is a lesson plan that focuses on math investigations.

https://www.thirteen.org/edonline/concept2class/inquiry/lp_math1.html

Examples of mathematical investigations that can be used in your classroom are found in the following site.

https://nrich.maths.org/search/?search=mathematical+investigations&tab=1&fs=111110000000111

Components of Mathematical Proficiency



comprehension of mathematical concepts, operations, and relations.

capacity for logical thought, reflection, explanation, and justification.

skill in carrying out procedures flexibly, accurately, efficiently, and appropriately.

capacity for logical thought, reflection, explanation, and justification.

habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy.

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

Check out the Summary of Key Math Resources and Implications for Practice.

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