

Mathematical Processes

These are described as the way we “do” math. In planning learning experiences, teachers need to embed opportunities to engage in these mathematical processes as much as possible:



Communication (See section of this guide on Communication in Math Class. Its so important, it has been given its own section!)



Connections: The only way we have to learn things is to connect them to something we already know. Everything we learn is strengthened by connections to other areas of study, life experiences, classroom experiences, and related mathematical concepts. An example is fractions being connected to shapes, sets, ratios, percents, number lines, decimals, and money. Vocabulary should connect words like “quadratic” to “quadrant”, “quad” (ATV—4 wheels), “quadruple”, etc. We connect the word “percent” to the French “cent” (100), and to “centipede”, “century”. We connect the number line to a thermometer, and the x, y axis to the number line, and so on. Gifted math teachers help learners make many connections!



Visualization is our ability to see relationships in our mind's eye. Mathematical thinking relies on visualization in seeing number relationships, manipulating shapes, and developing abstract thinking. Making math visual means presenting and having students present mathematical models. Teachers can model “think alouds” and have students draw what they’re thinking before solving a problem. Visual math is present in mathematical models such as ten frames, number lines, fraction representations, drawings and diagrams, graphs, and many technology supports such as desmos, illustrative maths, polypad, and other virtual manipulatives

<https://www.edutopia.org/article/power-visualization-math>



Representation is the process of creating models and diagrams to represent mathematical relationships. We can represent numbers many ways—as dots, fingers on hands, tally marks, ten frames, and numerals. Representations are mathematical models such as number lines, charts, diagrams, graphs, and algorithms. It is essential that students create mathematical representations when thinking through problems. Representations allow students to communicate their reasoning, explain, collaborate, and prove their results.



“Mathematical **reasoning** helps students think logically and make sense of mathematics. Students need to develop confidence in their abilities to reason and explain their mathematical thinking. High-order inquiry challenges students to think and develop a sense of wonder about mathematics.”-Sask Curriculum

Guide

Mathematical Processes con't

Reasoning (Con't) Students need opportunities to think to consolidate their reason. Reasoning and logic are foundations of mathematical thinking, and thinking mathematically trains our mind to apply reasoning to other disciplines. Assessments demand that students explain and justify their reasoning. Number talk routines help students develop flexible reasoning, as they listen to others conceptualize breaking numbers apart or describing shapes or situations.



Mental Math and Estimation: Estimation is an important skill in math to judge the reasonableness of our answers, to apply mathematical reasoning to real life situations, and to have a sense of size and quantity. Mental math is more than just computing without a pencil and paper—this is the aspect of mathematics that speaks to **flexible reasoning, procedural fluency, and fact recall**. Students need a certain level of automaticity with basic fact recall; otherwise their working memory is bogged down with calculation and they are not able to think about the deeper concepts or strategize to solve a problem.



Technology is more than the use of a calculator. Calculator use must be carefully considered based on the outcome. If the outcome is learning multiplication in grades 4 to 8, that is meant to help students recall facts and use strategies to multiply numbers—so a calculator would be an adaptation. If the outcome is area or distance within a problem, then we would expect if numbers are large that students multiply with a calculator. We can use the calculator as a teaching tool for students to notice patterns, and we can use it to verify results.

We also have technology for practice, such as Mathletics and IXL, and many online apps. Technology can show us real life examples of math, open a window to the world of applied mathematics, show us the history of mathematicians and the beauty of math in our universe, which makes the whole subject more engaging! The most effective technology in mathematics is teaching technology that helps students visualize, such as [exploding dots](#), [desmos](#), [polypad](#), [visualmaths](#), [geogebra](#), and others. You can find a more complete connection here <https://christtheteacher.ca/ctt/cttcmathhub/technology-for-learning/>

Hattie puts the effect size of web-based learning at 0.18 (not effective). Certainly, it has a role as an alternative to paper-pencil practice, and as a very sophisticated way to help students visualize mathematical relationships and engage students in math beyond the classroom. It is useful for number talks prompts and other challenges, and can be used to deliver instruction remotely. It can be good or bad—good if it enhances instruction and provides clarity, provides meaningful practice, and used as a reference tool; bad if there is an over-reliance on calculators, monotonous use of we-based practice, or programs replace robust instruction and collaboration.

These letters in the curriculum guide indicate which mathematical processes are embedded in the teaching of each outcome

N8.3

Demonstrate understanding of rates, ratios, and proportional reasoning concretely, pictorially, and symbolically. ([C, CN, PS, R, V])