BIG IDEAS

Mathematics has **developed** over many centuries and continues to evolve.	Mathematics is a global **language** used to understand the world.	**Societal needs** across cultures have influenced the development of mathematics.	**Tools and technology** are catalysts for mathematical development.	Notable **mathematicians** in history nurtured a sense of play and curiosity that led to the development of many areas in mathematics.

Learning Standards

Curricular Competencies	Content
Students are expected to do the following: **Reasoning and modelling** • Develop **thinking strategies** to solve historical puzzles and play games • Explore, **analyze**, and apply historical mathematical ideas using **reason**, **technology**, and **other tools** • **Think creatively** and with **curiosity and wonder** when exploring problems **Understanding and solving** • Critique multiple strategies used to solve mathematical problems throughout history • Develop, demonstrate, and apply conceptual understanding of mathematical ideas through play, story, **inquiry,** and problem solving • **Visualize** to explore and illustrate mathematical concepts and relationships • Apply **flexible and strategic approaches** to **solve problems** • Solve problems with **persistence and a positive disposition** • Engage in problem-solving experiences **connected** with place, story and cultural practices, including local First Peoples	*Students are expected to know the following:* • **number and number systems:** – written and oral numbers – zero – rational and irrational numbers – pi – prime numbers • **patterns and algebra:** – early algebraic thinking – variables – early uses of algebra – Cartesian plane – notation – Fibonacci sequence • **geometry:** – of lines, angles, triangles – Euclid's five postulates – geometric constructions – developments through time

Learning Standards (continued)

Curricular Competencies	Content
Communicating and representing • **Explain and justify** mathematical ideas and **decisions** in **many ways** • Use historical symbolic representations to explore mathematics • Use mathematical vocabulary and language to contribute to **discussions** in the classroom • Take risks when offering ideas in classroom **discourse** **Connecting and reflecting** • **Reflect** on mathematical thinking • **Connect mathematical concepts** with each other, with other areas, and with personal interests • Reflect on the consequences of mathematics culturally, socially, and politically • Use **mistakes** as **opportunities to advance learning** • **Incorporate** First Peoples worldviews, perspectives, **knowledge**, and **practices** to make connections with mathematical concepts	• **probability and statistics:** – Pascal's triangle – games involving probability – **early beginnings** of statistics and probability • **tools and technology:** development over time, from clay tablets to modern-day calculators and computers • **cryptography:** – use of ciphers, encryption, and decryption throughout history – modern uses of cryptography in war and digital applications

Big Ideas – Elaborations

- **developed:**
  Sample questions to support inquiry with students:
  - What is the connection between the development of mathematics and the history of humanity?
  - How have mathematicians overcome discrimination in order to advance the development of mathematics?
  - Where have similar mathematical developments occurred independently because of geographical separation?
- **language:**
  Sample questions to support inquiry with students:
  - How universal is the language of mathematics?
  - How is learning a language similar to learning mathematics?
  - How does oral language influence our conceptual understanding of mathematics?
- **Societal needs:**
  Sample questions to support inquiry with students:
  - Have societal needs always had a positive impact on mathematics?
  - How have politics influenced the development of mathematics?
  - How might mathematics influence decisions regarding social justice issues?
- **Tools and technology:**
  Sample questions to support inquiry with students:
  - Did tools and technology affect mathematical development or did mathematics affect the development of tools and technology?
  - What does technology enable us to do and how does this lead to deeper mathematical understanding?
- **mathematicians:**
  Sample questions to support inquiry with students:
  - What drives a mathematician to solve the seemingly unsolvable?
  - What do you wonder about in the mathematical world?
  - What are some examples of mathematical play that led to practical applications?

- **thinking strategies:**
  - using reason to determine winning strategies
  - generalizing and extending
- **analyze:**
  - examine the structure of and connections between mathematical ideas from historical contexts
- **reason:**
  - inductive and deductive reasoning
  - predictions, generalizations, conclusions drawn from experiences
- **technology:**
  - historically appropriate tools
  - can be used for a wide variety of purposes, including:
    - exploring and demonstrating mathematical relationships
    - organizing and displaying data
    - generating and testing inductive conjectures
    - mathematical modelling
    - presenting historical solutions or mathematical ideas from a current perspective
- **other tools:**
  - manipulatives such as rulers, compass, abacus, and other historically appropriate tools
- **Think creatively:**
  - by being open to trying different strategies
  - refers to creative and innovative mathematical thinking rather than to representing math in a creative way, such as through art or music
- **curiosity and wonder:**
  - asking questions to further understanding or to open other avenues of investigation
- **inquiry:**
  - includes structured, guided, and open inquiry
  - noticing and wondering
  - determining what is needed to make sense of and solve problems
- **Visualize:**
  - create and use mental images to support understanding
  - Visualization can be supported using dynamic materials (e.g., graphical relationships and simulations), concrete materials, drawings, and diagrams.

- **flexible and strategic approaches:**
  - deciding which mathematical tools to use to solve a problem
  - choosing an effective strategy to solve problems (e.g., guess and check, model, solve a simpler problem, use a chart, use diagrams, role-play, historical representations)
- **solve problems:**
  - interpret a situation to identify a problem
  - apply mathematics to solve the problem
  - analyze and evaluate the solution in terms of the initial context
  - repeat this cycle until a solution makes sense
- **persistence and a positive disposition:**
  - not giving up when facing a challenge and persevering through struggles (e.g., struggles of mathematicians and how their persistence led to mathematical discoveries)
  - problem solving with vigour and determination
- **connected:**
  - through daily activities, local and traditional practices, popular media and news events, cross-curricular integration
  - by posing and solving problems or asking questions about place, stories, and cultural practices
- **Explain and justify:**
  - use mathematical argument to convince
  - includes anticipating consequences
- **decisions:**
  - Have students explore which of two scenarios they would choose and then defend their choice.
- **many ways:**
  - including oral, written, visual, use of technology
  - communicating effectively according to what is being communicated and to whom
- **discussions:**
  - partner talks, small-group discussions, teacher-student conferences
- **discourse:**
  - is valuable for deepening understanding of concepts
  - can help clarify students' thinking, even if they are not sure about an idea or have misconceptions
- **Reflect:**
  - share the mathematical thinking of self and others, including evaluating strategies and solutions, extending, posing new problems and questions

Curricular Competencies – Elaborations

- **Connect mathematical concepts:**
  - to develop a sense of how mathematics helps us understand ourselves and the world around us (e.g., daily activities, local and traditional practices, popular media and news events, social justice, cross-curricular integration)
- **mistakes:**
  - range from calculation errors to misconceptions
- **opportunities to advance learning:**
  - by:
    - analyzing errors to discover misunderstandings
    - making adjustments in further attempts
    - identifying not only mistakes but also parts of a solution that are correct
- **Incorporate:**
  - by:
    - collaborating with Elders and knowledge keepers among local First Peoples
    - exploring the First Peoples Principles of Learning (e.g., Learning is holistic, reflexive, reflective, experiential, and relational [focused on connectedness, on reciprocal relationships, and a sense of place]; Learning involves patience and time)
    - making explicit connections with learning mathematics
    - exploring cultural practices and knowledge of local First Peoples and identifying mathematical connections
- **knowledge:**
  - local knowledge and cultural practices that are appropriate to share and that are non-appropriated
- **practices:**
  - Bishop's cultural practices: counting, measuring, locating, designing, playing, explaining
  - Aboriginal Education Resources
  - *Teaching Mathematics in a First Nations Context*, FNESC

Content – Elaborations

- **number and number systems:**
  - Egyptian, Babylonian, Roman, Greek, Arabic, Mayan, Indian, Chinese, First Peoples
  - exploring the idea of different bases, different forms of arithmetic
  - infinity
  - problems from the Rhind Mathematical Papyrus
  - Eratosthenes

Content – Elaborations

- **patterns and algebra:**
  - Al-Khwarizmi's *Algebra*
  - Indian mathematics
  - Islamic mathematics
  - Descartes
  - the golden ratio
  - patterns in art
- **geometry:**
  - problems from the Rhind Mathematical Papyrus, Moscow Mathematical Papyrus
  - Pythagoras
  - Hippocrates and construction problems of antiquity
  - geometry in Euclid's *Elements*, Archimedes, Apollonius, Pappus's *Book III*
  - Indian and Arabic contributions
  - Descartes and Fermat
- **probability and statistics:**
  - Pascal, Cardano, Fermat, Bernoulli, Laplace
  - ancient games such as dice and the Egyptian game Hounds and Jackals
  - Egyptian record keeping
  - Graunt and the development of statistics through the need for merchant insurance policies
- **early beginnings:**
  - forms of tabulating information, leading to the beginnings of probability and statistics
- **tools and technology:**
  - papyrus, stone tablet, bone, compass and straightedge, abacus, scales, slide rule, ruler, protractor, calculator, computer
- **cryptography:**
  - cuneiform
  - Spartan military use of ciphers
  - first documentation of ciphers in the Arab world
  - John Wallis
  - World War II and the Enigma machine
  - barcodes
  - modular arithmetic
  - RSA coding
  - current coding techniques and security in digital password encryption

