**Area of Learning: MATHEMATICS — Pre-calculus Grade 12**

**BIG IDEAS**

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| Using **inverses** is the foundation of solving equations and can be extended to relationships between functions. |  | Understanding the characteristics of families of **functions** allows us to model and understand relationshipsand to build connections between classes of functions. |  | **Transformations** of shapes extend to functions and relations in all of their representations. |

**Learning Standards**

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| **Curricular Competencies** | **Content** |
| *Students are expected to do the following:*Reasoning and modelling* Develop **thinking strategies** to solve puzzles and play games
* Explore, **analyze**, and apply mathematical ideas using **reason**, **technology**, and **other tools**
* **Estimate reasonably** and demonstrate **fluent, flexible, and strategic** thinking about number
* **Model** with mathematics in **situational contexts**
* **Think** **creatively** and with **curiosity and wonder** when exploring problems

Understanding and solving* 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, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures
 | *Students are expected to know the following:** **transformations** of functions and relations
* **exponential** functions and equations
* **geometric** sequences andseries
* **logarithms:** operations, functions, and equations
* **polynomial** functions and equations
* **rational** functions
* **trigonometry:** functions, equations, and identities
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**Area of Learning: MATHEMATICS — Pre-calculus Grade 12**

**Learning Standards (continued)**

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| **Curricular Competencies** | **Content** |
| Communicating and representing* **Explain and justify** mathematical ideas and **decisions** in **many ways**
* **Represent** mathematical ideas in concrete, pictorial, and symbolic forms
* 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, other areas, and personal interests
* Use **mistakes** as **opportunities to advance learning**
* **Incorporate** First Peoples worldviews, perspectives, **knowledge**, and **practices** to makeconnections with mathematical concepts
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|  **MATHEMATICS – Pre-calculus Big Ideas – Elaborations Grade 12** |
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| * **inverses:**
	+ *undo* the operations within an expression or function to reduce the expression to an identity (e.g., *x* = )

*Sample questions to support inquiry with students:** + How can the inverse help to solve an equation?
	+ How is solving an equation related to identifying the specific input for a function, given a specific output?
	+ How are exponential and l­­­ogarithmic functions related?
	+ How are the laws of exponents connected to the laws of logarithms?
	+ What are some other examples of inversely related functions?
	+ How are inverses related graphically, and why?
	+ How is solving an exponential equation similar to solving a trigonometric equation?
	+ How are inverse operations related to solving a polynomial equation by factoring?
	+ What is the value of using trigonometric identities to find equivalent expressions?
	+ Why do some equations have extraneous roots and other equations do not?
* **functions:**

*Sample questions to support inquiry with students:** + How do we decide which kind of function to use to model a given problem?
	+ What do functions and relations look like beyond the visible axes?
	+ A set of data looks like a parabola, but it is not. What function could be used to model this data?
	+ What does the number of zeros tell us about a function?
	+ What connections do we see within the characteristics of a particular class of function?
* **Transformations:**

*Sample questions to support inquiry with students:** + How can we tell whether a transformation will have invariant points?
	+ Under what circumstances will different transformations produce the same result?
	+ How do graphical transformations affect the tables of values?
	+ How does a transformation affect a point found at the origin as compared to a point on an axis or a point in one of the four quadrants?
	+ How can a rational function of the form $y=\frac{ax+b}{cx+d}$ be considered as a transformation of the reciprocal function $y=\frac{1}{x} $?
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|  **MATHEMATICS – Pre-calculus Curricular Competencies – Elaborations Grade 12** |
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| * **thinking strategies:**
	+ using reason to determine winning strategies
	+ generalizing and extending
* **analyze:**
	+ examine the structure of and connections between mathematical ideas (e.g., exponential functions to geometric sequences)
* **reason:**
	+ inductive and deductivereasoning
	+ predictions, generalizations, conclusions drawn from experiences (e.g., with puzzles, games, and coding)
* **technology:**
	+ graphing technology, dynamic geometry, calculators, virtual manipulatives, concept-based apps
	+ can be used to for a wide variety of purposes, including:
		- exploring and demonstrating mathematical relationships
		- organizing and displaying data
		- generating and testing inductive conjectures
		- mathematical modelling
* **other tools:**
	+ manipulatives such as algebra tiles and other concrete materials
* **Estimate reasonably:**
	+ be able to defend the reasonableness of an estimated value or a solution to a problem or equation (e.g., the zeros of a graphed polynomial function)
* **fluent, flexible and strategic thinking:**
	+ includes:
		- using known facts and benchmarks, partitioning, applying whole number strategies to rational numbers and algebraic expressions
		- choosing from different ways to think of a number or operation (e.g., Which will be the most strategic or efficient?)
* **Model:**
	+ use mathematical concepts and tools to solve problems and make decisions (e.g., in real-life and/or abstract scenarios)
	+ take a complex, essentially non-mathematical scenario and figure out what mathematical concepts and tools are needed to make sense of it
* **situational contexts:**
	+ including real-life scenarios and open-ended challenges that connect mathematics with everyday life
* **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 a problem (e.g., guess and check, model, solve a simpler problem, use a chart, use diagrams, role-play)
* **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
	+ 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 arguments 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
* **Represent:**
	+ using models, tables, graphs, words, numbers, symbols
	+ connecting meanings among various representations
* **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
* **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](http://www.fnesc.ca/wp/wp-content/uploads/2015/09/PUB-LFP-POSTER-Principles-of-Learning-First-Peoples-poster-11x17.pdf) (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](http://www.csus.edu/indiv/o/oreyd/ACP.htm_files/abishop.htm): counting, measuring, locating, designing, playing, explaining
	+ [Aboriginal Education Resources](http://www.aboriginaleducation.ca/)
	+ [*Teaching Mathematics in a First Nations Context*,](http://www.fnesc.ca/resources/math-first-peoples/) FNESC
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|  **MATHEMATICS – Pre-calculus Content – Elaborations Grade 12** |
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| * **transformations:**
	+ of graphs and equations of parent functions and relations (e.g., absolute value, radical, reciprocal, conics, exponential, logarithmic, trigonometric)
	+ vertical and horizontal translations, stretches, and reflections
	+ inverses: graphs and equations
	+ extension:
		- recognizing composed functions (e.g., $y=$)
		- operations on functions
* **exponential:**
	+ graphing, including transformations
	+ solving equations with same base and with different bases, including base *e*
	+ solving problems in situational contexts
* **geometric:**
	+ common ratio, first term, general term
	+ geometric sequences connecting to exponential functions
	+ infinite geometric series
	+ sigma notation
* **logarithms:**
	+ applying laws of logarithms
	+ evaluating with different bases
	+ using common and natural logarithms
	+ exploring inverse of exponential
	+ graphing, including transformations
	+ solving equations with same base and with different bases
	+ solving problems in situational contexts
* **polynomial:**
	+ factoring, including the factor theorem and the remainder theorem
	+ graphing and the characteristics of a graph (e.g., degree, extrema, zeros, end-behaviour)
	+ solving equations algebraically and graphically
* **rational:**
	+ characteristics of graphs, including asymptotes, intercepts, point discontinuities, domain, end-behaviour
* **trigonometry:**
	+ examining angles in standard position in both radians and degrees
	+ exploring unit circle, reference and coterminal angles, special angles
	+ graphing primary trigonometric functions, including transformations and characteristics
	+ solving first- and second-degree equations (over restricted domains and all real numbers)
	+ solving problems in situational contexts
	+ using identities to reduce complexity in expressions and solve equations (e.g., Pythagorean, quotient, double angle, reciprocal, sum and difference)
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