**Area of Learning: MATHEMATICS — Geometry Grade 12**

**BIG IDEAS**

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| **Diagrams** are fundamental to investigating, communicating, and discovering properties and relations in geometry. |  | Finding **invariance amidst** **variation** drives geometric investigation. |  | Geometry involves creating, testing, and refining **definitions**. |  | The **proving process** begins with conjecturing, looking for counter-examples, and refining the conjecture, and the process may end with a written proof. |  | **Geometry** stories and applications vary across cultures and time. |

**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 * Engage in **spatial reasoning** in a dynamic environment * 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 geometric concepts and relationships * Apply **flexible and strategic approaches** to **solve problems** * Solve problems with **persistence and a positive disposition** * Engage in problem-solvingexperiences **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:*   * geometric **constructions** * **parallel and perpendicular** lines:   + **circles as tools** in constructions   + perpendicular bisector * **circle geometry** * **constructing tangents** * transformations of 2D shapes:   + **isometries**   + **non-isometric transformations** * **non-Euclidean geometries** |

**Area of Learning: MATHEMATICS — Geometry Grade 12**

**Learning Standards (continued)**

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| **Curricular Competencies** | **Content** |
| Communicating and representing   * **Explain, justify,** and evaluate geometric ideas and **decisions** in  **many ways** * **Represent** mathematical ideas in concrete, pictorial, and  symbolic forms * Use geometric vocabulary and language to contribute to **discussions**  in the classroom * Take riskswhen offering ideas in classroom **discourse**   Connecting and reflecting   * **Reflect** on geometric 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 make connections with mathematical concepts |  |

| **MATHEMATICS – Geometry  Big Ideas – Elaborations Grade 12** |
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| * **Diagrams:**   *Sample questions to support inquiry with students:*   * + How would we describe a specific geometric object to someone who cannot see it?   + What properties can we infer from a diagram?   + What behaviours can we infer from a dynamic diagram? * **invariance amidst variation:**   + Invariance amidst variation can be more easily experienced using current technology and dynamic diagrams. For example, the sum of the  angles in planar triangles is invariant no matter what forms a triangle takes.   *Sample questions to support inquiry with students:*   * + How do we construct geometric shapes that maintain properties under variation?   + What properties change and stay the same when we vary a square, parallelogram, triangle, and so on?   + How can the Pythagorean theorem be restated in terms of variance and invariance? * **definitions:**   + are seldom the starting point in geometry   *Sample questions to support inquiry with students:*   * + How does variation help to refine our definitions of shapes?   + How would we define a square (or a circle) in different ways? When would one definition be better to work with than another?   + How can the definition of a shape be used in constructing the shape?   + How can we modify a definition of a shape to define a new shape? * **proving process:**   *Sample questions to support inquiry with students:*   * + Can we make a conjecture about the diagonals of a polygon? Can we find a counter-example to our conjecture?   + How can one conjecture about a *specific* shape lead to making another more *general* conjecture about a family of shapes?   + How can we be sure that a proof is complete?   + Can we find a counter-example to a conjecture?   + How can different proofs bring out different understandings of a relationship? * **Geometry:**   + Geometry is more than a list of axioms and deductions. Non-Western and modern geometry is concerned with shape and space and is not always axiomatic. It is not always about producing a theorem; rather, it is about modelling mathematical and non-mathematical phenomena  using geometric objects and relations. Today geometry is used in a multitude of disciplines, including animation, architecture, biology, carpentry, chemistry, medical imaging, and art.   *Sample questions to support inquiry with students:*   * + Can we find geometric relationships in local First Peoples art or culture?   + Can we make geometric connections to story, language, or past experiences?   + What do we notice about and how would we construct common shapes found in local First Peoples art?   + How has the notion of “proof” changed over time and in different cultures?   + How are geometric ideas implemented in modern professions? |

| **MATHEMATICS – Geometry  Curricular Competencies – Elaborations Grade 12** |
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| * **thinking strategies:**   + using reason to determine winning strategies   + generalizing and extending * **spatial reasoning:**   + being able to think about shapes (real or imagined) and mentally transform them to notice relationships * **analyze:**   + examine the structure of and connections between geometric ideas (e.g., parallel and perpendicular lines, circle geometry,  constructing tangents, transformations) * **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 for a wide variety of purposes, including:     - exploring and demonstrating geometrical relationships     - organizing and displaying data     - generating and testing inductive conjectures     - mathematical modelling * **other tools:**   + paper and scissors, straightedge and compass, ruler, 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., congruencies, angles, lengths) * **fluent, flexible, and strategic thinking:**   + being able to generate a family of shapes and apply characteristics across the family * **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 geometrical 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, gestures use of technology   + communicating effectively according to what is being communicated and to whom * **Represent:**   + concretely, diagrammatically, symbolically, including using models, tables, graphs, words, numbers, symbols * **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 geometric thinking of self and others, including evaluating strategies and solutions, finding counter-examples, extending, posing new problems and questions, proving results * **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 |

| **MATHEMATICS – Geometry  Content – Elaborations Grade 12** |
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| * **constructions:**   + angles, triangles, triangle centres, quadrilaterals * **parallel and perpendicular:**   + angle bisector * **circles as tools:**   + constructing equal segments, midpoints * **circle geometry:**   + properties of chords, angles, and tangents to mobilize the proving process * **constructing tangents:**   + lines tangent to circles, circles tangent to circles, circles tangent to three objects (e.g., points [PPP], three lines [LLL]) * **isometries:**   + transformations that maintain congruence (translations, rotations, reflections)   + composition of isometries   + tessellations * **non-isometric transformations:**   + dilations and shear   + topology * **non-Euclidean geometries:**   + perspective, spherical, Taxicab, hyperbolic   + tessellations |