Area of Learning: Mathematics	**Apprenticeship Mathematics 12**
Big Ideas	Elaborations

• **Design** involves investigating, planning, creating, and evaluating.	• **Design:**
	• *Sample questions to support inquiry with students:*
	  ○ How is a product designed?
	  ○ How can the design process be applied to meet a need or solve a problem?

• Constructing **3D objects** often requires a 2D plan.	• **3D objects:**
	• *Sample questions to support inquiry with students:*
	  ○ What are some limitations that result when 3D objects are represented in 2D?
	  ○ Which type of 2D representation would be the most appropriate for a 3D object?
	  ○ How does visualization help when solving problems?
	  ○ How does visualization help break down a larger problem?

• **Transferring mathematical skills** between problems requires conceptual understanding and flexible thinking.	• **Transferring mathematical skills:**
	• *Sample questions to support inquiry with students:*
	  ○ How does awareness and knowledge of mathematics in the workplace make learning more meaningful?
	  ○ What is the mathematics required for a particular trade of interest?

• **Proportional reasoning** is used to make sense of multiplicative relationships.	• **Proportional reasoning:**
	  ○ reasoning about comparisons of relative size or scale instead of numerical difference
	  ○ ways of showing proportional comparison when analyzing problems in situational contexts
	  – scale diagrams
	  – rates of change
	• *Sample questions to support inquiry with students:*
	  ○ How are proportions used to solve problems?
	  ○ What is the importance of proportional reasoning when making sense of the relationship between two things?

• Choosing a tool based on required precision and accuracy is important when **measuring**.	• **measuring:** • *Sample questions to support inquiry with students:*

		○ What skills are required for measuring with accuracy? ○ What is the importance of choosing appropriate tools and units when measuring? ○ What are the implications of inaccurate measurements?	
Learning Standards			
Curricular Competencies	Elaborations	Content	Elaborations
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 context**s • **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**	• **thinking strategies:** ○ using reason to determine winning strategies ○ generalizing and extending • **analyze:** ○ examine the structure of and connections between mathematical ideas (e.g., proportional reasoning, metric/imperial conversions) • **reason:** ○ inductive and deductive reasoning ○ 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 mathematical relationships – organizing and displaying data – generating and testing inductive	*Students are expected to know the following:* • **measuring:** using tools with graduated scales; conversions using metric and imperial • similar **triangles:** including right-angle trigonometry • 2D and 3D shapes: including area, surface area, volume, and nets • **3D objects** and their views (isometric drawing, orthographic projection) • **mathematics in the workplace** • **financial literacy:** business investments and loans	• **measuring:** ○ unit analysis ○ precision and accuracy ○ breaking of units into smaller divisions to get more precise measurements ○ extension: project or presentation to share measurement concepts and skills used in a field/career of interest • **triangles:** ○ situational examples such as stairs and roofs ○ application of Pythagorean theorem ○ situations involving multiple right-angle triangles • **3D objects:** ○ creating and reading various types of technical drawings ○ extension: project or presentation to share geometry concepts and skills used in a field/career of interest • **mathematics in the workplace:** ○ compare and contrast mathematics used in different workplace contexts ○ interview someone working in a field

• 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 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 make connections with mathematical concepts	conjectures – mathematical modelling • **other tools:** o manipulatives such as rulers and other measuring tools • **Estimate reasonably:** o be able to defend the reasonableness of an estimated value or a solution to a problem or equation (e.g., reasonableness of measurements) • **fluent, flexible, and strategic thinking:** o including: – using known facts and benchmarks, partitioning, applying whole number strategies to expressions involving proportional reasoning, financial analysis, and logic – choosing from different ways to think of a number or operation (e.g., Which will be the most strategic or efficient?) • **Model:** o use mathematical concepts and tools to solve problems and make decisions (e.g., in real-life and/or abstract scenarios) o take a complex, essentially non-mathematical scenario and figure out what mathematical concepts and		of interest o extension: project that includes an element of design and mathematical thinking • **financial literacy:** o business investments, loans (lease versus buy), graphical representations of financial growth, projections, expenses o extension: project or presentation to share mathematical concepts and skills used in a field/career of interest

	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 ○ communicating effectively according to what is being communicated and to whom • **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: counting, measuring, locating, designing, playing, explaining (http://www.csus.edu/indiv/o/oreyd/ACP.htm_files/abishop.htm) ○ Aboriginal Education Resources (www.aboriginaleducation.ca) ○ *Teaching Mathematics in a First*		

Comment [mw1]: Carpe Diem: Possible to embed link in FPPL, or does URL have to be visible?

	Nations Context, FNESC (http://www.fnesc.ca/resources/math-first-peoples/)		