

Area of Learning: Mathematics		Statistics 12	
Big Ideas		Elaborations	
<ul style="list-style-type: none"> <li>• <b>Statistics</b> plays an integral role in research, decision making, and policy in society.</li> </ul>		<ul style="list-style-type: none"> <li>• <b>Statistics:</b></li> <li>• <i>Sample questions to support inquiry with students:</i> <ul style="list-style-type: none"> <li>○ Why is statistical thinking important in our lives?</li> <li>○ How do the statistical sciences help us make decisions?</li> <li>○ What is the role of statistics in the scientific process?</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>• The research question and practical and ethical issues determine whether a <b>statistical study</b> should be observational or experimental.</li> </ul>		<ul style="list-style-type: none"> <li>• <b>statistical study:</b></li> <li>• <i>Sample questions to support inquiry with students:</i> <ul style="list-style-type: none"> <li>○ How do studies obtaining data enable us to explore research questions?</li> <li>○ What features of a study will make it effective, practical, and ethical for exploring a research question?</li> <li>○ How do we conduct an effective observational study?</li> <li>○ How do we conduct an effective designed experiment?</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>• <b>Statistical analysis</b> allows us to explore, describe, model, and explain variation.</li> </ul>		<ul style="list-style-type: none"> <li>• <b>Statistical analysis:</b></li> <li>• <i>Sample questions to support inquiry with students:</i> <ul style="list-style-type: none"> <li>○ Why is it important to explore and understand variation?</li> <li>○ How can we describe variation graphically?</li> <li>○ What is the role of probabilistic models for describing variation?</li> <li>○ Can we describe the sampling variation of a statistic, such as the sample mean?</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>• We can develop <b>statistical thinking</b> to help make inferences intuitive.</li> </ul>		<ul style="list-style-type: none"> <li>• <b>statistical thinking:</b></li> <li>• <i>Sample questions to support inquiry with students:</i> <ul style="list-style-type: none"> <li>○ How can we explore the sampling distribution of a statistic?</li> <li>○ What properties of a sample statistic make it a good estimator of a population parameter?</li> <li>○ How can technology help us appreciate the properties of a confidence interval?</li> <li>○ How surprising are the data from a study if the research hypothesis is true?</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>• Statistical findings gain value through <b>effective communication</b>.</li> </ul>		<ul style="list-style-type: none"> <li>• <b>effective communication:</b></li> <li>• <i>Sample questions to support inquiry with students:</i> <ul style="list-style-type: none"> <li>○ Why is the communication of statistical findings important?</li> <li>○ How can we best communicate statistical findings verbally and in writing?</li> <li>○ What are the roles of context and the target audience in the communication of</li> </ul> </li> </ul>	

		statistical findings? ○ How can technology assist us in the communication of statistical ideas?	
Curricular Competencies	Elaborations	Content	Elaborations
<p><i>Students are expected to do the following:</i></p> <p>Reasoning and modelling</p> <ul style="list-style-type: none"> <li>• Develop <b>thinking strategies</b> to solve puzzles and play games</li> <li>• Explore, <b>analyze</b>, and apply statistical ideas using <b>reason, technology, and other tools</b></li> <li>• <b>Estimate reasonably</b> and demonstrate <b>fluent, flexible, and strategic thinking</b> about number</li> <li>• <b>Model</b> with statistics in <b>situational contexts</b></li> <li>• <b>Think creatively</b> and with <b>curiosity and wonder</b> when exploring problems</li> </ul> <p>Understanding and solving</p> <ul style="list-style-type: none"> <li>• Develop, demonstrate, and apply conceptual understanding of statistical ideas through play, story, <b>inquiry</b>, and research</li> <li>• <b>Visualize</b> to explore and illustrate variation within and between variables</li> <li>• Apply <b>flexible and strategic approaches</b> to explore statistical questions in abstract and situational contexts</li> <li>• Explore research questions with <b>persistence and a positive disposition</b></li> <li>• Engage in <b>statistical thinking</b> to answer</li> </ul>	<ul style="list-style-type: none"> <li>• <b>thinking strategies:</b> <ul style="list-style-type: none"> <li>○ using reason to determine winning strategies</li> <li>○ generalizing and extending</li> </ul> </li> <li>• <b>analyze:</b> <ul style="list-style-type: none"> <li>○ consider a research problem and determine viable investigation approaches</li> <li>○ critique existing studies, identifying possible flaws and limitations</li> <li>○ draw viable conclusions from a statistical study</li> </ul> </li> <li>• <b>reason:</b> <ul style="list-style-type: none"> <li>○ inductive and deductive reasoning</li> <li>○ predictions, generalizations, conclusions drawn from experiences (e.g., with games and simulations)</li> </ul> </li> <li>• <b>technology:</b> <ul style="list-style-type: none"> <li>○ software for recording, exploring, and communicating data</li> <li>○ software tools for illustrating and providing information on probability models</li> <li>○ web-based visualisation/simulation tools that give intuition to inferential concepts</li> </ul> </li> <li>• <b>other tools:</b> <ul style="list-style-type: none"> <li>○ manipulatives such as dice, coins, spinners, and other concrete materials</li> </ul> </li> <li>• <b>Estimate reasonably:</b> <ul style="list-style-type: none"> <li>○ be able to justify the use of an</li> </ul> </li> </ul>	<p><i>Students are expected to know the following:</i></p> <ul style="list-style-type: none"> <li>• <b>role of statistical thinking</b> in research and the scientific method</li> <li>• <b>observational</b> and <b>experimental</b> studies</li> <li>• common <b>graphical</b> representations of variation</li> <li>• use of <b>summary statistics</b> to describe variation</li> <li>• <b>association</b> between two variables</li> <li>• probability <b>models</b> for variation</li> <li>• intuition and appreciation of <b>inferential concepts</b>, such as confidence intervals and hypothesis tests</li> <li>• use of <b>software and technology</b> to enhance statistical ideas</li> <li>• <b>communication</b> of statistical findings</li> </ul>	<ul style="list-style-type: none"> <li>• <b>role of statistical thinking:</b> <ul style="list-style-type: none"> <li>○ census versus sample</li> <li>○ identifying research questions and target population</li> <li>○ historical perspective on the development of statistical research and theories</li> <li>○ role of data in helping to answer questions (e.g., Lind study on scurvy, 1753); randomization as a fairly recent development</li> </ul> </li> <li>• <b>observational:</b> <ul style="list-style-type: none"> <li>○ Observational studies involve observation of a sample from the target population, without intervention.</li> <li>○ Observational studies can include surveys and questionnaires.</li> <li>○ When are observational studies necessary and appropriate?</li> <li>○ What are the limitations of observation studies?</li> <li>○ Lurking variables can impact conclusions.</li> <li>○ The wording of survey items can incur bias.</li> <li>○ How should we design an observational study to explore an appropriate research question?</li> </ul> </li> <li>• <b>experimental:</b> <ul style="list-style-type: none"> <li>○ Experimental studies involve intervention for collection of data.</li> </ul> </li> </ul>

<p>questions <b>connected</b> with place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures</p> <p>Communicating and representing</p> <ul style="list-style-type: none"> <li>• <b>Explain and justify</b> statistical thinking and <b>decisions in many ways</b></li> <li>• <b>Represent</b> statistical ideas in concrete, pictorial, and symbolic forms</li> <li>• Use statistical vocabulary and language to contribute to <b>discussions</b> in the classroom</li> <li>• Take risks when offering ideas in classroom <b>discourse</b></li> </ul> <p>Connecting and reflecting</p> <ul style="list-style-type: none"> <li>• <b>Reflect</b> on statistical thinking</li> <li>• <b>Connect statistical concepts</b> with each other, other areas, and personal interests</li> <li>• Use <b>mistakes as opportunities to advance learning</b></li> <li>• <b>Incorporate</b> First Peoples worldviews, perspectives, <b>knowledge</b>, and <b>practices</b> to make connections with statistical concepts</li> </ul>	<p>estimate in a statistical context</p> <ul style="list-style-type: none"> <li>○ appreciate that statistical estimators exhibit variation across different samples</li> <li>○ use intuition when sampling distributions via simulations to make inferences</li> </ul> <ul style="list-style-type: none"> <li>• <b>fluent, flexible, and strategic thinking:</b> <ul style="list-style-type: none"> <li>○ includes: <ul style="list-style-type: none"> <li>– appreciating the role of variation</li> <li>– choosing from different ways to investigate a research question (e.g., Which will be the most appropriate?)</li> </ul> </li> </ul> </li> <li>• <b>Model:</b> <ul style="list-style-type: none"> <li>○ use mathematical concepts and tools to solve problems and make decisions (e.g., in real-life and/or abstract scenarios)</li> <li>○ take a complex, essentially non-mathematical scenario and figure out what mathematical concepts and tools are needed to make sense of it</li> </ul> </li> <li>• <b>situational contexts:</b> <ul style="list-style-type: none"> <li>○ including real-life scenarios and open-ended challenges that connect mathematics with everyday life</li> </ul> </li> <li>• <b>Think creatively:</b> <ul style="list-style-type: none"> <li>○ by: <ul style="list-style-type: none"> <li>– being open to trying different strategies</li> <li>– appreciating that in statistical contexts, there is often no single correct answer</li> </ul> </li> </ul> </li> </ul>		<ul style="list-style-type: none"> <li>○ Randomization of treatments to experimental units can eliminate issues with lurking variables and bias.</li> <li>○ There may be practical and ethical concerns (e.g., long-duration studies on smoking, effectiveness of medications).</li> <li>○ How should we design an experiment to explore an appropriate research question?</li> </ul> <ul style="list-style-type: none"> <li>• <b>graphical:</b> <ul style="list-style-type: none"> <li>○ Graphical methods should always be used to explore data.</li> <li>○ Graphical approaches can display data distributions.</li> <li>○ Focus on interpreting data through bar charts, histograms, dot plots, boxplots, scatterplots, tables.</li> <li>○ Graphical approaches can be used to explore the association between variables (e.g., clustered bar charts, scatterplots).</li> <li>○ Software should be used (e.g., Minitab).</li> <li>○ What are the advantages and disadvantages of different representations?</li> </ul> </li> <li>• <b>summary statistics:</b> <ul style="list-style-type: none"> <li>○ measures of centre, spread (range, variance, standard deviation interquartile range), including five-number summary</li> <li>○ use of Chebyshev's inequality</li> <li>○ use of correlation in measuring association between quantitative variables</li> </ul> </li> </ul>
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	<ul style="list-style-type: none"> <li>– proposing a viable research question for investigation</li> <li>– designing a study to explore a research question</li> <li>○ refers to creative and innovative mathematical thinking rather than to representing math in a creative way, such as through art or music</li> <li>• <b>curiosity and wonder:</b> <ul style="list-style-type: none"> <li>○ asking questions to further understanding or to open other avenues of investigation</li> </ul> </li> <li>• <b>inquiry:</b> <ul style="list-style-type: none"> <li>○ includes structured, guided, and open inquiry</li> <li>○ noticing and wondering</li> <li>○ determining what is appropriate to explore in a research question</li> </ul> </li> <li>• <b>Visualize:</b> <ul style="list-style-type: none"> <li>○ create and use mental images to support understanding</li> <li>○ Visualization can be supported using dynamic materials (e.g., graphical relationships and simulations), concrete materials, drawings, and diagrams.</li> </ul> </li> <li>• <b>flexible and strategic approaches:</b> <ul style="list-style-type: none"> <li>○ deciding which statistical ideas are useful in addressing a research question or hypothesis</li> <li>○ choosing an effective strategy to address a research question (e.g., observational or experimental study, choice of variable[s] to measure, display method, inferential</li> </ul> </li> </ul>		<ul style="list-style-type: none"> <li>• <b>association:</b> <ul style="list-style-type: none"> <li>○ categorical variables: contingency tables — clustered, stacked bar charts</li> <li>○ quantitative variables: scatterplots</li> <li>○ correlation and causation</li> </ul> </li> <li>• <b>models:</b> <ul style="list-style-type: none"> <li>○ binomial distribution: <ul style="list-style-type: none"> <li>– When is it appropriate?</li> <li>– What does it model?</li> <li>– What assumptions can be made?</li> <li>– Shape of distribution affected by <math>n</math> and <math>p</math>.</li> </ul> </li> <li>○ normal (Gaussian) distribution: <ul style="list-style-type: none"> <li>– when it is useful</li> <li>– roles of the mean and standard deviation, 68-95-99.7 rule</li> </ul> </li> <li>○ central limit theorem: describing the variation of a sample mean</li> <li>○ use of simulation software to explore sampling distributions</li> </ul> </li> <li>• <b>inferential concepts:</b> <ul style="list-style-type: none"> <li>○ making intuitive inferences based on a large number of simulations</li> <li>○ intuition on interval, estimation of means and proportions via simulation</li> <li>○ inference for proportion via simulation (randomization/permutation tests)</li> <li>○ inference for a mean via simulation (randomization/permutation tests)</li> <li>○ two-sample questions via simulation (randomization/permutation tests)</li> </ul> </li> <li>• <b>software and technology:</b> <ul style="list-style-type: none"> <li>○ Software can assist us in exploring and summarizing data.</li> </ul> </li> </ul>
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	<p>approaches)</p> <ul style="list-style-type: none"> <li>• <b>persistence and a positive disposition:</b> <ul style="list-style-type: none"> <li>○ not giving up when facing a challenge</li> <li>○ engaging in research and exploration with vigour and determination</li> </ul> </li> <li>• <b>statistical thinking:</b> <ul style="list-style-type: none"> <li>○ gain deeper understanding through data collected to answer questions about local cultures</li> </ul> </li> <li>• <b>connected:</b> <ul style="list-style-type: none"> <li>○ through daily activities, local and traditional practices, popular media and news events, cross-curricular integration</li> <li>○ by posing and solving problems or asking questions about place, stories, and cultural practices.</li> </ul> </li> <li>• <b>Explain and justify:</b> <ul style="list-style-type: none"> <li>○ use arguments based on statistical thinking to convince</li> <li>○ includes anticipating consequences</li> </ul> </li> <li>• <b>decisions:</b> <ul style="list-style-type: none"> <li>○ Have students explore which of two scenarios they would choose and then defend their choice.</li> </ul> </li> <li>• <b>many ways:</b> <ul style="list-style-type: none"> <li>○ including oral, written, visual, use of technology</li> <li>○ communicating effectively according to what is being communicated and to whom</li> </ul> </li> <li>• <b>Represent:</b> <ul style="list-style-type: none"> <li>○ using models, simulations, tables, graphs, words, numbers, symbols</li> <li>○ connecting meanings among various</li> </ul> </li> </ul>		<ul style="list-style-type: none"> <li>○ Online simulation-based learning tools can help us gain intuition of inferential concepts, such as sampling distribution, interval estimation, and hypothesis tests.</li> <li>• <b>communication:</b> <ul style="list-style-type: none"> <li>○ communicating statistical findings in context, appropriate to the target audience</li> <li>○ writing a report on a research project involving an observational study</li> <li>○ writing a report on a research project involving a designed experiment</li> <li>○ presenting to an audience on a research project involving an observational study</li> <li>○ presenting to an audience on a research project involving a designed experiment</li> </ul> </li> </ul>
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	<ul style="list-style-type: none"> <li>representations <ul style="list-style-type: none"> <li>○ using concrete materials and dynamic statistical software (applets/simulation tools) to explore variation</li> </ul> </li> <li>• <b>discussions:</b> <ul style="list-style-type: none"> <li>○ partner talks, small-group discussions, teacher-student conferences</li> </ul> </li> <li>• <b>discourse:</b> <ul style="list-style-type: none"> <li>○ is valuable for deepening understanding of concepts</li> <li>○ can help clarify students' thinking, even if they are not sure about an idea or have misconceptions</li> </ul> </li> <li>• <b>Reflect:</b> <ul style="list-style-type: none"> <li>○ share the statistical thinking of self and others, including evaluating strategies and solutions, extending, posing new problems and questions</li> </ul> </li> <li>• <b>Connect mathematical concepts:</b> <ul style="list-style-type: none"> <li>○ to develop a sense of how statistics 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)</li> </ul> </li> <li>• <b>mistakes:</b> <ul style="list-style-type: none"> <li>○ range from calculation errors to misconceptions</li> </ul> </li> <li>• <b>opportunities to advance learning:</b> <ul style="list-style-type: none"> <li>○ by: <ul style="list-style-type: none"> <li>– analyzing errors to discover misunderstandings</li> <li>– making adjustments in further</li> </ul> </li> </ul> </li> </ul>		
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	<p>attempts</p> <ul style="list-style-type: none"> <li>– identifying not only mistakes but also parts of a solution that are correct</li> </ul> <ul style="list-style-type: none"> <li>• <b>Incorporate:</b> <ul style="list-style-type: none"> <li>○ by: <ul style="list-style-type: none"> <li>– collaborating with Elders and knowledge keepers among local First Peoples</li> <li>– exploring the First Peoples Principles of Learning (<a href="http://www.fnesc.ca/wp/wp-content/uploads/2015/09/PUB-LFP-POSTER-Principles-of-Learning-First-Peoples-poster-11x17.pdf">http://www.fnesc.ca/wp/wp-content/uploads/2015/09/PUB-LFP-POSTER-Principles-of-Learning-First-Peoples-poster-11x17.pdf</a>); 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) <ul style="list-style-type: none"> <li>– making explicit connections with learning mathematics</li> <li>– exploring cultural practices and knowledge of local First Peoples and identifying mathematical connections</li> </ul> </li> </ul> </li> </ul> </li> <li>• <b>knowledge:</b> <ul style="list-style-type: none"> <li>○ local knowledge and cultural practices that are appropriate to share and that are non-appropriated</li> </ul> </li> </ul>		
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**Comment [mw1]:** Carpe Diem: Possible to embed link in FPPL, or does URL have to be visible?

	<ul style="list-style-type: none"><li>• <b>practices:</b><ul style="list-style-type: none"><li>○ Bishop's cultural practices: counting, measuring, locating, designing, playing, explaining (<a href="http://www.csus.edu/indiv/o/oreyd/ACP.htm">http://www.csus.edu/indiv/o/oreyd/ACP.htm</a> files/abishop.htm)</li><li>○ Aboriginal Education Resources (<a href="http://www.aboriginaleducation.ca">www.aboriginaleducation.ca</a>)</li><li>○ <i>Teaching Mathematics in a First Nations Context</i>, FNEC (<a href="http://www.fnesc.ca/resources/math-first-peoples/">http://www.fnesc.ca/resources/math-first-peoples/</a>)</li></ul></li></ul>		
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