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

**BIG IDEAS**

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| **Statistics** plays an integral role in research, decision making, and policy in society. |  | The research question and practical and ethical issues determine whether a **statistical study** should be observational or experimental. |  | **Statistical analysis** allows us to explore, describe, model, and explain variation. |  | We can develop **statistical thinking** to help make inferences intuitive. |  | Statistical findings gain value through **effective communication**. |

**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 statistical ideas using **reason**, **technology**, and **other tools** * **Estimate reasonably** and demonstrate **fluent, flexible, and strategic thinking** about number * **Model** with statistics in **situational contexts** * **Think creatively** and with **curiosity and wonder** when exploring problems   Understanding and solving   * Develop, demonstrate, and apply conceptual understanding of statistical ideas through play, story, **inquiry**, and research * **Visualize** to explore and illustrate variation within and between variables * Apply **flexible and strategic approaches** to explore statistical questions in abstract and situational contexts * Explore research questions with **persistence and a positive disposition** * Engage in **statistical thinking** to answer questions **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:*   * **role of statistical thinking** in research and the scientific method * **observational** and **experimental** studies * common **graphical** representations of variation * use of **summary statistics** to describe variation * **association** between two variables * probability **models** for variation * intuition and appreciation of **inferential concepts**, such as confidence intervals and hypothesis tests * use of **software and technology** to enhance statistical ideas * **communication** of statistical findings |

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

**Learning Standards (continued)**

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

| **MATHEMATICS – Statistics  Big Ideas – Elaborations Grade 12** |
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| * **Statistics:**   *Sample questions to support inquiry with students:*   * + Why is statistical thinking important in our lives?   + How do the statistical sciences help us make decisions?   + What is the role of statistics in the scientific process? * **statistical study:**   *Sample questions to support inquiry with students:*   * + How do studies obtaining data enable us to explore research questions?   + What features of a study will make it effective, practical, and ethical for exploring a research question?   + How do we conduct an effective observational study?   + How do we conduct an effective designed experiment? * **Statistical analysis:**   *Sample questions to support inquiry with students:*   * + Why is it important to explore and understand variation?   + How can we describe variation graphically?   + What is the role of probabilistic models for describing variation?   + Can we describe the sampling variation of a statistic, such as the sample mean? * **statistical thinking:**   *Sample questions to support inquiry with students:*   * + How can we explore the sampling distribution of a statistic?   + What properties of a sample statistic make it a good estimator of a population parameter?   + How can technology help us appreciate the properties of a confidence interval?   + How surprising are the data from a study if the research hypothesis is true? * **effective communication:**   *Sample questions to support inquiry with students:*   * + Why is the communication of statistical findings important?   + How can we best communicate statistical findings verbally and in writing?   + What are the roles of context and the target audience in the communication of statistical findings?   + How can technology assist us in the communication of statistical ideas? |

| **MATHEMATICS – Statistics  Curricular Competencies – Elaborations Grade 12** |
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| * **thinking strategies:**   + using reason to determine winning strategies   + generalizing and extending * **analyze:**   + consider a research problem and determine viable investigation approaches   + critique existing studies, identifying possible flaws and limitations   + draw viable conclusions from a statistical study * **reason:**   + inductive and deductivereasoning   + predictions, generalizations, conclusions drawn from experiences (e.g., with games and simulations) * **technology:**   + software for recording, exploring, and communicating data   + software tools for illustrating and providing information on probability models   + web-based visualisation/simulation tools that give intuition to inferential concepts * **other tools:**   + manipulatives such as dice, coins, spinners, and other concrete materials * **Estimate reasonably:**   + be able to justify the use of an estimate in a statistical context   + appreciate that statistical estimators exhibit variation across different samples   + use intuition when sampling distributions via simulations to make inferences * **fluent, flexible, and strategic thinking:**   + includes:     - appreciating the role of variation     - choosing from different ways to investigate a research question (e.g., Which will be the most appropriate?) * **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     - appreciating that in statistical contexts, there is often no single correct answer     - proposing a viable research question for investigation     - designing a study to explore a research question   + 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 appropriate to explore in a research question * **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 statistical ideas are useful in addressing a research question or hypothesis   + choosing an effective strategy to address a research question (e.g., observational or experimental study, choice of variable[s] to measure, display method, inferential approaches) * **persistence and a positive disposition:**   + not giving up when facing a challenge   + engaging in research and exploration with vigour and determination * **statistical thinking:**   + gain deeper understanding through data collected to answer questions about local cultures * **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 arguments based on statistical thinking 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, simulations, tables, graphs, words, numbers, symbols   + connecting meanings among various representations   + using concrete materials and dynamic statistical software (applets/simulation tools) to explore variation * **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 statistical thinking of self and others, including evaluating strategies and solutions, extending, posing new problems and questions * **Connect statistical 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 – Statistics  Content – Elaborations Grade 12** |
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| * **role of statistical thinking:**    + census versus sample   + identifying research questions and target population   + historical perspective on the development of statistical research and theories   + role of data in helping to answer questions (e.g., Lind study on scurvy, 1753); randomization as a fairly recent development * **observational:**   + Observational studies involve observation of a sample from the target population, without intervention.   + Observational studies can include surveys and questionnaires.   + When are observational studies necessary and appropriate?   + What are the limitations of observation studies?   + Lurking variables can impact conclusions.   + The wording of survey items can incur bias.   + How should we design an observational study to explore an appropriate research question? * **experimental:**   + Experimental studies involve intervention for collection of data.   + Randomization of treatments to experimental units can eliminate issues with lurking variables and bias.   + There may be practical and ethical concerns (e.g., long-duration studies on smoking, effectiveness of medications).   + How should we design an experiment to explore an appropriate research question? * **graphical:**   + Graphical methods should always be used to explore data.   + Graphical approaches can display data distributions.   + Focus on interpreting data through bar charts, histograms, dot plots, boxplots, scatterplots, tables.   + Graphical approaches can be used to explore the association between variables (e.g., clustered bar charts, scatterplots).   + Software should be used (e.g., Minitab).   + What are the advantages and disadvantages of different representations? * **summary statistics:**   + measures of centre, spread (range, variance, standard deviation interquartile range), including five-number summary   + use of Chebyshev’s inequality   + use of correlation in measuring association between quantitative variables * **association:**   + categorical variables: contingency tables — clustered, stacked bar charts   + quantitative variables: scatterplots   + correlation and causation * **models:**   + binomial distribution:     - When is it appropriate?     - What does it model?     - What assumptions can be made?     - Shape of distribution affected by n and p.   + normal (Gaussian) distribution:     - when it is useful     - roles of the mean and standard deviation, 68-95-99.7 rule   + central limit theorem: describing the variation of a sample mean   + use of simulation software to explore sampling distributions * **inferential concepts:**   + making intuitive inferences based on a large number of simulations   + intuition on interval, estimation of means and proportions via simulation   + inference for proportion via simulation (randomization/permutation tests)   + inference for a mean via simulation (randomization/permutation tests)   + two-sample questions via simulation (randomization/permutation tests) * **software and technology:**   + Software can assist us in exploring and summarizing data.   + Online simulation-based learning tools can help us gain intuition of inferential concepts, such as sampling distribution, interval estimation, and hypothesis tests. * **communication:**   + communicating statistical findings in context, appropriate to the target audience   + writing a report on a research project involving an observational study   + writing a report on a research project involving a designed experiment   + presenting to an audience on a research project involving an observational study   + presenting to an audience on a research project involving a designed experiment |