Curriculum Refresh and Statistics - specific changes

A curriculum in statistics for changing times

This statement comes from the Education Committee of the NZ Statistical Association, in March 2022. We intend it primarily as a resource for the Ministry of Education and its team of writers in the learning area of *Mathematics and Statistics*.

We see it as vitally important that Aotearoa New Zealand has a curriculum in statistics that is resilient to the rapid changes in the world of data and statistical practice, and that meets the special needs of this country. We are keen to support the writing team in any way we can.

Our statement about **the larger issues** for a curriculum in statistics are in the document: *A vision for statistics and data science education at the senior secondary level in Aotearoa New Zealand*: Statistics and data science at CL7/8 (censusatschool.org.nz).The curriculum part of the statement is Appendix A. References and resources are at Appendices C and D.

This present document states **the specific changes** that we see as needed to get from the Curriculum of 2007 to the new one. It includes a number of detailed requests. Some will require considerable work and research.

Please see also the inputs of Anna Fergusson and Dr Pip Arnold, into the *Report to the Ministry of Education: Mathematics and statistics skills and knowledge learners need to know*, of September 2021.

Scope of the curriculum

The 2007 curriculum is on one page. Many ideas are packed into one phrase or sentence, which makes it difficult for teachers to interpret. Consider returning to the scope of the 1992 curriculum, where achievement objectives for each level are supplemented with learning activities and assessment examples. It is important to do this when the curriculum is released, and not later. This also will help in the writing of the curriculum. Through examples, teachers get a better idea about what curriculum statements mean, and what works.

Structure of the curriculum

- Debate the eight existing Curriculum Levels versus year levels. What is best for teachers? Aotearoa NZ has a large transitory school population, and the structure of the curriculum and the teaching of topics needs to deal with this.

- The three statistical ‘threads’ in the 2007 curriculum should remain.

Writing the curriculum

- Draw on future-focused statistics education research internationally (e.g., USA, Germany, Israel) and particularly in New Zealand. Start with statistics education journals (*Statistics Education Research Journal* SERJ, *Journal of Statistics and Data Science Education* JSDSE, *Technology Innovation in Statistics Education* TISE), and not mathematics education research journals. See also the International Association for Statistics Education (IASE) conference proceedings.

- The 2007 curriculum has fairly generic statements. Keep statements as generic as possible to allow for interpretation in the future as well as the present. Write with a future-focused mind as a curriculum lasts for at least 15 years, and because the statistics discipline is rapidly changing in response to technology and the push towards data science. For example, statements concerning modelling should be broad enough to include classification modelling, predictive modelling, training and testing of models, etc.

- Digital technology use should be assumed and encouraged at all levels. Ākonga should be introduced to using statistical software initially through tools that help to develop conceptual understanding and have more flexibility in their use e.g., *CODAP, Common Online Data Analysis Platform*, CODAP - Common Online Data Analysis Platform (concord.org) , *Tinkerplots*, TinkerPlots: Home.
  Later, ākonga need to use tools that enable data exploration and analysis, e.g. INZight, iNZight for Data Analysis.
  Also, later, ākonga need to use software that demonstrates the concepts of resampling methods, and carries out the inference processes; e.g. *VIT: Visual Inference tools*; VIT: Visual Inference Tools (auckland.ac.nz). Note that while there is scope to integrate computational thinking with statistical thinking, including using computer programming, this requires different pedagogical approaches.

- Contextual knowledge about the data being collected, analysed, etc., is paramount, and this focus should be retained from the 2007 curriculum. As the famous saying of Cobb and Moore states, “data are not just numbers, they are numbers with a context.”

- Let teachers know that what is published will continue to change over the lifetime of the curriculum. Design and publicise a process which provides the curriculum with regular or ongoing review.

- Highlight the idea that ākonga are novice statisticians. Across the levels they are learning the practice of statistics (what statisticians do), and at the same time co-constructing and developing statistical knowledge and concepts.

- Because statistics is changing so rapidly, the big ideas and knowledge areas can no longer be entangled with mathematics. Statistics uses mathematical ideas and fundamental knowledge, but it is not mathematics. It has its own way of thinking and doing and is an independent discipline in its own right.

- Ensure that the curriculum can accommodate the 21st century growth in the importance to citizens of statistics (and mathematics). Plenty of this growth has happened, and more is coming. The Ministry has signalled its awareness here by raising the possibility of a third subject around year 13.

What content areas in the statistics curriculum need a lot more work?

- The development of ideas about categorical data seems to stop before high school, and reappears in Year 12 for risk, and Year 13 in probability and confidence intervals involving proportions. With the rise of modern data, a curriculum pathway needs to be developed in the categorical data area for data analysis and modelling.

- In the statistical investigation thread, consideration needs to be given to including new

types of ways to extract data (e.g., data extracted from text, photos, images), and new types of visualisations.

- 21st century ideas and progressions for probability were not addressed in any great detail in the 2007 curriculum revision. Major work needs to be undertaken across all years to include statistical/probability modelling using technology such as *TinkerPlot*s. Although dice, spinners, urns, games of chance problems, etc. still have a place in the curriculum, there is also a need for students to build and tinker with models to model a situation, the result of which they can compare to data gathered from the real situation. This area needs a large amount of careful research and work.

- Relationship situations (bivariate data, with scatterplots) and time series need better curriculum infrastructure across the levels, to show how ākonga ideas can progress over time. The difference between experiments and observational studies needs to be specifically addressed for relationship situations. So does how to reason and draw conclusions from such studies.

- The importance of evidence-based thinking for citizens is getting more and more acute. Therefore, the statistical literacy thread needs to be supplemented with many new considerations that are being identified in the literature. For example, ethics, algorithmic bias, new data visualisations, indigenous data sovereignty, teaching ākonga how to read text with non-obvious statistical claims (See Iddo Gal, IASE webinar https://iase-web.org/Webinars.php?p=211215_1900), statistics and citizenship.

- Risk literacy needs a great deal of work. You could start with three short articles published in *Significance*, *Volume 18*, 2021 (Authors, Tracey Martin, Chris Franklin, Leonor Sierra) for risk know-how, and in particular the risk know-how framework which details what ākonga need to know. (If you cannot access these articles, please ask us and we will send them to you.)

- An issue related to probability and proportion is rates, as in epidemiological rates.

What content areas and concepts can be moved lower in the curriculum?

Several concept areas can be introduced earlier in the learning paths of ākonga. For example:

- Using medians, from CL4
- The idea of distribution e.g. describing shape, from CL4
- Scatterplots, from CL4
- Time series, from CL3
- Using tables for categorical data, proportions - single proportions CL1, using two-way tables including joint and conditional proportions, from CL4
- Using simple measurement data, from CL3
- Actually introducing simple experiment concepts, from CL5 - it is in the current curriculum but not done

See *Statistical Investigations* | *Te Tūhurahanga Tauanga*, Pip Arnold, Tony Trinick, Maxine Pfannkuch, in preparation.

Another important resource, from overseas, is *Pre-K-12 Guidelines for Assessment and Instruction in Statistics Education (GAISE II)* See also Introducing GAISE II: A Guideline for Precollege Statistics and Data Science Education · Issue 2.4, Fall 2020 (mit.edu). The GAISE II

document also may suggest ideas for content that can be moved lower in the curriculum, ideas that could be developed in middle school for example, that we currently leave until higher up.

Other issues

- The status of statistics curriculum with respect to other subjects that use data. Has the statistics been taught before ākonga meet it in another subject? Are other subjects using statistical concepts with meaning or just teaching a rule? Are the same data displays and language being used? Do the teachers use the same technology (e.g., *CODAP*)?

- The relationship of the mathematics strands to the statistics strand. Is one assisting the other? For example, measurement in mathematics and data collection of measurements. Is one not assisting the other? For example, use of the terminology modelling, when modelling is viewed in different ways.

- How does the curriculum document contribute to equity and access? We know that the Ministry wants the new curriculum to be bicultural by design, and to help create equity and inclusion for all ākonga. We see that statistics, with its foundation in contexts and questions that matter to communities and workers, will be an essential part in addressing these issues.