Statistics in schools: how statisticians can support the paradigm shift

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1. Introduction: a paradigm shift for school mathematics

The school mathematics of the 20th century was mainly about deterministic models of the world. The school mathematics for the 21st century needs a new balance between deterministic and stochastic models. This will require a paradigm shift that needs the expertise of both mathematics educators and statisticians. New Zealand (NZ) took large steps towards this new balance with Mathematics in the New Zealand Curriculum (1992), and the assessment documents that followed it. The current review of the entire New Zealand school curriculum gives the chance for more steps. Mumford argues that stochastic models and statistical reasoning are more relevant to the world, science, mathematics and our own minds than exact models and logical reasoning. (Mumford 1999). This paper assumes that Mumford's argument can be applied to school mathematics and statistics. It summarizes recent New Zealand experience, and draws conclusions about how a new balance can be reached. The views belong to the author, and not necessarily to Statustics NZ, the NZ Statistical Association or its Education Committee.

2. Our history since 1992, and some conclusions from it

In 1986, the New Zealand Statistical Association set up its Education Committee (EC), with the immediate aim of supporting teachers in the then new statistical project for year 13. The EC consisted of a mix of practitioners and teachers (tertiary and secondary), who were clear that an exploratory data analysis approach could give statistics a lively presence in all the school years. In 1991, the NZ Ministry of Education (MoE) drafted a curriculum document for years 1 to 13. The EC developed a structure for a statistics strand, and presented this to the curriculum writers. The resulting *Mathematics in the New Zealand Curriculum* (Ministry of Education, 1992) has statistics and probability as one of its five 'strands' from year 1 to year 13. Since 1992, EC has made input into assessment standards and tasks that follow from it, and raised statistical issues at teacher conferences. Our history leads to two conclusions.

The first is about the remarkable synergy between mathematics educators and statisticians. Both groups, in 1992, were seeking change, but they were on converging paths. The mathematics educators wrote 'mathematical processes' (problem-solving, logic and communication) into the curriculum. The statisticians provided a structure of increasingly interesting variables, datasets and situations. This structure now underlies the statistics 'strand' that runs from year 1 to year 13, and is one of the five strands of the curriculum. While 'statistical processes' are not mentioned, the strand has three sub-strands that imply processes: statistical investigations, interpreting statistical reports and exploring probability.

The second is about the need for mathematics educators and statisticians to work together on the design and writing of curriculum and assessment statements. Statistics is very new for many mathematics educators. There are many concepts and terms that need to be used precisely in statistics. A central example is the concept of a dataset, with its categorical and/or numerical variables, and their distributions. Our experience shows that, if statements are to be well-structured and clear, then statistician input into them is essential.

3. Issues emerging in the current curriculum review process

The current review lets us address issues that have clarified since 1992.

The first concerns the balance between deterministic and stochastic ways of thinking. To achieve a better balance between them, we will need to research which skills are most useful, and at what ages they can best be learnt, and how the two sides can reinforce each other. (For example, numeracy has high priority in New Zealand. It can be learnt, with motivating contexts, via data exploration.) A better balance will involve an energizing paradigm shift both for mathematics educators and statisticians. Statisticians have a vital role in leading, motivating and supporting teachers wishing to make the shift. A very visible part of the shift may be the name of the subject: perhaps 'Mathematics' can be renamed 'Mathematics and Statistics'.

The second involves 'statistical thinking'. This set of concepts was clarified by Wild and Pfannkuch (1999), and has already made its way into the Statistics and Modelling Scholarship Standard (Ministry of Education, 2003) for year 13 students. Together with 'mathematical thinking', it needs to be stated as central in the new curriculum documents.

The third is about the links with other subjects, and the contents of other subjects . We need to ensure that the statistical expectations in other curriculum statements (in science, technology, social science, economics etc) are in line with our 21st century view, and that they are met by the statistical part of the mathematics curriculum. A good relationship should strengthen both our subject and the other subjects.

The fourth is about curriculum issues that go across and beyond subjects. Begg and Pfannkuch (2004) state that 'one of the general aims of education is the development of wisdom', and recommends that 'thinking' be the major focus of curriculum for the 21st century. The development of wisdom and thinking, along with values and attitudes, can be related to the learning of statistics. There is new ground for all parties here.

4. Conclusion

The EC's experience suggests that the mathematics education community is open to a new role for statistics in schools, and is keen to apply its energy and creativity to this. Consistent input and support from the statistical community can release this energy, and help us shift to a school mathematics and statistics that will be most useful for life in the 21st century.

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RÉSUMÉ

Ce document célèbre deux choses: l'endroit vital que les statistiques peuvent prendre dans l'écoles du 21e siècle et le rôle vital que la communauté statistique prend atteindre ceci. Ce document utilise l'expérience en Nouvelle Zélande comme un exemple.