STRENGTHENING THE INTERPLAY OF PROBABILITY AND STATISTICS IN TEACHING AND IN TRAINING THE TEACHERS

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BRIEF OVERVIEW OF SCHOOL LEVEL BACKGROUND IN TWO COUNTRIES

Although details differ from state to state in Australia, Chance and Data have been strands in the grades 1 to 10 mathematics curriculum since the early 1990's. The emphasis has been, and continues to be, on data-driven and hands-on learning experiences with very gradual development of concepts of chance and its language, data investigations, displays and their features, and variation. There are greater differences across state curricula in the senior school grades 11 and 12, but most states, in consultation with university members of the statistical education community, have progressed in the influence of data-driven statistical investigations within senior school syllabi. The extent of development of statistical concepts and models varies according to the strand of mathematics within the senior syllabi. That is, students in core senior mathematics subjects involving algebra and introductory calculus are able to see foundational concepts of statistical models linking data and probability.

In South Africa, statistics (covering chance and data) is currently being introduced into grades 1-12 mathematics curriculum. The introduction to descriptive data starts very slowly in grade 1, and chance first appears in the syllabus in grade 4.

In both countries, statisticians have been, and continue to be, involved in statistics education. The Australian author has been extensively involved in curriculum consultation and writing, and professional development workshops for senior school teachers since 1992, and for the Data strand for grades 1-10 since 2002. An example of a recent summary of core learning outcomes in grades 1-10, can be found at http://www.qsa.qld.edu.au/downloads/syllabus/kla_maths_clo.doc. The South African author has been intensively involved in developing curriculum and materials and workshops for teachers since 1999, and now as a master trainer in South Africa's "train the trainer" program in StatsSA's Maths4Stats campaign.

For both authors, the above involvement was in response to requests for help from educational authorities and teachers. Both authors have worked extensively with practising teachers who have relished the direct contact with statisticians with expertise and experience in teaching many and varied students at school/tertiary and tertiary/workplace interfaces. The questions to, and observations of, the authors are thus from the teaching coalface across all of schooling and from many teachers.

LESSONS AND CHALLENGES

It was not necessary to wait until 2002 in Australia to see the effects of students experiencing Chance and Data across their 12 years of schooling, as teachers, students and parents provided ongoing feedback and comments, with the most common complaint being of boredom with "doing the same things over and over". In contrast, students whose teachers' backgrounds had included sufficient study of statistics, tended to report positively, sometimes even enthusiastically, of their school learning experiences in statistics. It was clear that a more developmental curriculum framework was needed, together with more guidance for teachers.

All learners need coherence, flow and a sense of destination in their learning. Teachers as learners need to know and understand how the components of their teaching fit in the curriculum and in the overall learning journey of their students. Teachers' questions and comments show that this is particularly true for statistics (Chance and Data) because of the multi-dimensional and complex nature of statistical thinking (Wild & Pfannkuch, 1999; Moore, 1999). What has become very clear in developing syllabi and professional support in collaboration with practising teachers is that there are certain critical landmarks for teachers in the overall landscape and perspectives of statistics across educational levels.

 In C. Batanero, G. Burrill, C. Reading & A. Rossman (Eds.), *Joint ICMI/IASE Study: Teaching Statistics in School Mathematics. Challenges for Teaching and Teacher Education. Proceedings of the ICMI Study 18 and 2008 IASE Round Table Conference*.

Within Data, the framework and key landmarks are the development of understanding of types of data and their handling in planning, collecting, exploring, representing, and commenting on data. A framework can move slowly and steadily from simple categorical to two categorical variables, count and continuous, with the gradual development of concepts of variation and estimation. Within Chance, the landmarks tend to be associated with use of language and comparisons of likeliness leading to the seeding concepts of modelling of, and with, probability through equally-likely situations. However, too much or too long a focus on the traditional and basic equally-likely scenarios of coins, dice and "balls in boxes", stultifies growth and, for students and teachers, eventually turns Chance into a backwater of boredom and unreality. An advanced landmark that may be introduced in senior school and that combines chance and data is the concept of chance of obtaining observed data under assumptions – the concept that underpins statistical testing no matter what philosophy is followed. It is of the utmost importance that school teachers understand that their students can only comment on features of data until errors of estimation and probability distributions are met. Emphasis on posing and answering definite questions must be avoided.

The most obvious interplay between chance and data in pre-inference and pre-modelling learning is through estimation of probabilities by relative frequencies, but the rich potential of this interplay needs to be strengthened. The Australian author's work with curriculum and teachers has focussed much on data and data investigations, integrating chance through estimation of probabilities in real and everyday scenarios throughout the gradual building of concepts, language and tools in the framework of types of data. The South African author has focussed much on games of chance beyond the simple and elementary, integrating data to estimate more complex probabilities. Data-driven learning and developing understanding of variation permeates both approaches.

This presentation outlines approaches that strengthen the interplay between chance and data throughout a framework for teachers that will assist them in understanding and teaching the gradual development of foundations for statistical literacy, reasoning and thinking across school levels. The interplay comes from a combination of using data to estimate probability and interpreting language within the development of the three main types of data – categorical, count and continuous. In moving from single and simple categorical variables to two categorical variables and tables of data, the use of relative frequencies to estimate conditional probabilities without formal concepts provides rich learning experiences in critical language aspects of statistical literacy, as espoused by Schield (2006). Estimating probabilities for count variables facilitates better understanding of the nature of count data and prevents the serious consequences of confusion between count data and frequencies. Estimating probabilities of intervals for continuous data assists in building the foundations for understanding the nature of continuous variables and their probability structures and ensures that a clear message is not to treat continuous data as if it were discrete. Finally, an example of data collection and estimation of the chance of winning a game of chance with slightly unequal outcomes demonstrates how relative frequencies can be used in developing understanding of both variation and the notion that a small probability is not a zero chance.

CONCLUSION

Through data, teachers can gradually and coherently develop understanding of essential foundations for probability models. Estimating probabilities by relative frequencies in the contexts of three main data types provides a natural framework for gradual development of concepts, problems and language, a sound foundation for the more mathematical model development to be easier at a later stage, many opportunities for activities and discussion, understanding of foundational concepts and prevention of misconceptions.

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