Book Reviews

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1. Introduction

This book is one outcome of an attempt to address issues relating to statistics at the pre-college level through the creation of an interdisciplinary working group consisting of mathematics educators, cognitive scientists, teachers, and statisticians. The brief was to address the challenge in a manner that could help teachers and researchers make informed decisions about how to introduce statistics in grades K-12. A premise shared by the contributors is that by introducing statistics in the K-12 period, students will be better prepared for decision making in the real world. This volume represents an interdisciplinary effort to construct an understanding of how to enhance statistics education and assessment for students in elementary and secondary schools.

2. An overview of the book

2.1 Section 1: "Statistical Content for School Mathematics"

In the first section – on the statistical content of school mathematics – it is rightly pointed out, the issues of *statistical content* and *conceptual understanding* need to be investigated concurrently, and there is a dearth of such studies. Nevertheless some progress has been made, and one aim of this book is to encourage further work. At this level in particular the issue of how *informal* knowledge can be used as a guide to instruction is important. Most work has been in the rather limited field of probability, but work on children's intuitions about modelling is reported. As the introduction says, "only by documenting cognitive skills and the characteristics that differentiate the skilled from the unskilled learner for each content area ... can we improve the teaching and assessment of such under-

standing". The section provides a clear indication of the capabilities of high school students and how progression can be promoted. A significant theme is the need to develop critical skills and attitude to statistical data, rather than simply computational and presentational skills. This is exemplified by the laudable assertion that "every high-school graduate must be educated to be an intelligent consumer of data ... and to judge the value of data produced by others". The point is well made that statistics is about numbers *in context*.

2.2 Section 2: "Teaching Statistics"
The second section has chapters on graphical representation and professional development for teachers. The authors address the issue of how to build on students' prior knowledge in the context of graphical representation and data interpretation, emphasising the construction of relationships and extending understanding through multiple contexts. There is discussion of the problems of teacher education and an innovative professional development programme is described.

2.3 Section 3: "Learning Statistics"
The third section contains three chapters. The first two provide detailed examinations of the development of understanding of chance and uncertainty, demonstrating transitions in mental models of statistical understanding. The third chapter explores simulations as vehicles for statistical understanding.

2.4 Section 4: "Assessing Statistics"
The fourth section is on assessment which has an important role in both shaping the curriculum and informing teacher and student of progress made. The point is made that statistical understanding is difficult to define and assess in general terms and communication is a key concept. Verbal rather than written modes of working (and assessing) may be more appropriate, and multiple methods of assessment need to be encouraged. A theme throughout the book is the need to marry instruction and assessment into a unified whole curriculum.

3. A closer look at chapters of the book

3.1 Chapter 1: "What every high school graduate should know"
This chapter, by the respected authorities Sheaffer, Watkins and Landwehr, is a *tour de force* of statistics at the school level, with excellent sections on number sense, variables,

tables and graphs, planning a study, surveys, experimental design, data analysis, relationship between probability and statistics, and between combinatorics and probability, variables, inferential reasoning, simulation. Furthermore, a five-page appendix lists recommendations for the curriculum from many bodies including the American Statistical Association, the National Council for Teaching Mathematics and – interestingly – the American Association for the Advancement of Science who shows the place of statistics beyond the discipline of mathematics.

3.2 Chapter 2: "Statistics and Probability for the Middle Grades"

This chapter, by Burrill and Romberg, reports on a curriculum entitled *Mathematics in Context* devised using funding from the National Science Foundation. In addressing ideas not commonly taught in American schools (or elsewhere ...) it has sought to identify the "big ideas" appropriate to this level, linking the discussion to pedagogical issues and the supporting mathematical concepts. A feature is the worthy vision that the units "should enable students to understand the role of statistics and probability in their own lives as well as within the context of mathematics". The curriculum is seen as forming a bridge between the intuitive and informal notions and the formal statistics to come later. The chapter describes the units and includes good suggestions for meaningful project work. Another excellent feature is the inclusion of 13 pages of examples of students' work and explanations, with appropriate commentary.

3.3 Chapter 3: "Graphical Representations: Helping Students Interpret Data"

This chapter, by Bright and Friel, concentrates on the analysis phase of the overall statistical process where "data are organised into graphs", with a reminder that a graph never is (never should be) an end in itself. Topics covered include bar and line graphs, stem-and-leaf plots. The term histogram is defined as a means to "represent data that have been grouped into intervals" which is unfortunate. A good feature is the reporting of students' comments on interpreting graphs.

3.4 Chapter 4: "Teach-Stat: A Model for Professional Development"

This chapter, by Friel and Bright, describes a funded project designed to develop a programme for elementary teachers (grades 1–6) to help them learn more about statistics and to assist them to integrate statistics into their teaching. This is a useful report on an aspect rarely found in such books, and includes a valuable detailed concept map of the process of statistical investigation and examples of the units prepared for the professional development programme. Their conclusion is that "When the study of statistics is framed within the context of a process of statistical investigation and involves the use of relevant 'hands-on' applications and activities, teachers and students quickly become engaged ... (and it) provides for a much more open learning environment. No longer is there 'one right way' ... with 'one right answer' ...".

3.5 Chapter 5: "A Model-Based Perspective on the Development of Children's Understanding of Chance and Uncertainty"

This chapter, by Horvath and Lehrer, begins by elaborating on the cognitive status of five components of the classical model of chance. Topics covered are distinguishing between certainty and uncertainty, the nature of the experimental trial, the relationship between simple events and distributions, the structure of events, the treatment of residuals. It then goes on to report at some length on studies of pupils' and adults' performances on tasks, providing much insight in this fascinating area.

3.6 Chapter 6: "Emergent Ideas of Chance and Probability in Primary-Grade Children"

This chapter, by Metz, analyses the research literature to identify pupils' intuitions on which a primary grade curriculum could be built and in the process identifies five key intuitions: relative magnitude, part-whole relations, incertitude and indeterminacy, likelihood of an event, and (in limited form) distribution of an event.

3.7 Chapter 7: "Developing Middle-School Students' Statistical Reasoning Abilities Through Simulation Games"

This chapter, by Derry et al., reports on a specific project developing and evaluating a three-week instructional unit for middle-grade students. This consisted of viewing a popular movie involving medical research ethics, clinical trials, regulations etc. followed by a lengthy mock legislative hearing involving presentations by instructors and evaluation by students. Sophisticated assessment tasks were developed to test students' understanding. Although this may not interest many readers it could provide very useful ideas for some.

3.8 Chapter 8: "Monitoring Student Progress in Statistics"

This chapter, by Lajoie et al., describes the *Authentic Statistics Project* and demonstrates that multiple sources of evidence of learning can be collected through different modes of assessment which allow for more valid indications of what students learn.

3.9 Chapter 9: "Aligning Everyday and Mathematical Reasoning: The Case of Sampling Assumptions"

This chapter, by Schwartz et al., reports on three studies looking at fifth-and sixth-grade students' evolving notions of sampling and statistical inference. The main findings showed that, not surprisingly, the context has a profound influence on students' assumptions about the purpose and validity of a sample. This is a fascinating and challenging chapter for the teacher of statistics.

3.10 Chapter 10: "Assessing Statistical Knowledge as it Relates to Students' Interpretation of Data"

This chapter, by Gal, explores some conceptual and practical challenges that assessment of *interpretative* (as opposed to *generative*) skills poses to the teacher. The chapter begins by reflecting on the goals of statistical education and then considers the issues involved in eliciting and evaluating students' views on data (using 2 by 2 tables as

illustration) and finally discusses the implications for assessment and research and professional development.

3.11 Chapter 11: "Reflections on a Statistics Agenda for K-12"

This is an epilogue by the book's editor drawing together the outcomes of the previous chapters and setting down a list of tasks for the future which may inspire future researchers in this exciting field.

4. Conclusion

The book is very well written, and well edited, with very few errors. It is written in a relatively easy to read style without sacrificing accuracy. Each chapter has lengthy reference lists which could lead the interested reader into whole areas to explore and develop – enough for a lifetime's work in many cases. There is, by its nature, a strong bias to the US research and educational scene but nevertheless this is a valuable addition to the literature, of interest to teacher, lecturer and researcher alike. Further books of this standard reporting more internationally in the field would be most welcome!

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