About This Book

Since the publication of *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics [NCTM] 1989), increasing attention has been placed on data analysis as a coherent strand of the school mathematics curriculum. *Principles and Standards for School Mathematics* (NCTM 2000) sets forth the Data Analysis and Probability Standard, which presents three clear standards for performance in data analysis (see the margin notes). These three standards overlap the elements of the process of statistical investigation shown in chapter 1.

This book offers activities that further students' understanding of the full range of data analysis as an identifiable strand of mathematics content. The four chapters illustrate the general notion of statistics as a process while also provoking discussions of increasingly complex mathematical issues.

Chapter 1, "Setting the Stage for Data Analysis," extends and deepens students' knowledge of data analysis. The important ideas include the following:

- Data analysis as a process
- Interrogating a data set
- Useful language
- Numerical summaries

This chapter extends what students already know about representing data with graphs and numerical summaries and interpreting the graphs and summaries to make sense of the set of data—that is, to interrogate the data set.

Chapter 2, "Comparing Data Sets with Equal Numbers of Elements," introduces the comparison of data sets when the numbers of data points in the sets are the same (i.e., equal *N*s). Such comparisons stretch students' reasoning beyond simple descriptions of a data set. The essential ideas include the following:

- Spread and variability
- Shapes of distributions
- Reasoning about data

One purpose of comparing data sets is to decide if they represent populations that are the same or different. When the data sets to be compared have equal numbers of elements, additive reasoning suffices, but the groundwork is laid in such comparisons for more-sophisticated kinds of reasoning.

Chapter 3, "Comparing Data Sets with Unequal Numbers of Elements," makes the transition to the comparison of data sets with numbers of data points that are not the same (i.e., unequal *N*s). Multiplicative reasoning is necessary for interpreting comparisons of data sets with unequal *N*s. The important ideas include these:

- Relative frequency
- Box plots
- Multiplicative reasoning

Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them

Select and use appropriate statistical methods to analyze data

Develop and evaluate inferences and predictions that are based on data

Chapter 3 helps students develop the techniques necessary for determining whether two data sets represent the same or different populations. Accurate determinations are central to making "inferences and predictions that are based on data" (NCTM 2000, p. 248) rather than on assumptions about the data or the populations from which the data are taken.

Chapter 4, "Exploring Bivariate Data," introduces students to the analysis of data involving two variables. The main ideas include—

- bivariate data, and
- scatterplots and prediction.

Bivariate data are created when two characteristics are measured for each element in a sample. One of the central tasks in understanding bivariate data is inferring whether the characteristics are related.

Each chapter begins with a discussion of the important mathematical ideas that it treats. Then an activity is presented that helps teachers understand what knowledge their students might already have about these ideas. This preassessment activity is followed by other activities, many of which have blackline masters that can be used directly with students. The blackline masters, signaled by an icon, can be found in the appendix, along with solutions to the problems where appropriate. They can also be printed from the CD-ROM that accompanies the book. The CD-ROM, also signaled by an icon, includes resources for professional development and three minitools that provide an alternative way of engaging students with some of the same mathematical ideas presented in the book. Throughout the book, an icon appears in the margin next to references to *Principles and Standards for School Mathematics.*

Teachers can help students learn important ideas about data analysis in many ways. What is most important is to select activities that help students develop a conceptual understanding of the ideas while also making sense of data. Tasks need to be sequenced carefully and coordinated with assessments of students' thinking so that both individual students and the class as a whole can progress to increasingly sophisticated reasoning. Returning to familiar ideas in new contexts is often necessary. For example, when a new representation (e.g., a histogram) is introduced, it may be necessary to return to interrogating a single data set as a means of helping students become comfortable with the ideas related to the new representation. Students must understand each new idea before they can use it in sophisticated ways.

Some of the activities in this book can be conducted without access to technology, but many evolving technologies can assist students in becoming proficient at interrogating data. The accompanying CD-ROM includes Excel files of all the data in the book for the convenience of teachers who want their students to use and manipulate the data on the computer. Students can display the data in a variety of tables and charts, through which they can discover patterns, relationships, recursive and explicit behavior, functions, and limits. Today's statisticians often use computer software to help them conduct "interactive data analysis," an analysis of data that evolves as different representations of the data are displayed and interpreted. Because computers can compute and display data very quickly, the information in a data set can be examined from many different perspectives, each of

Key to Icons


Principles and Standards


CD-ROM


Blackline Master

Three different icons appear in the book, as shown in the key. One alerts readers to material quoted from *Principles and Standards for School Mathematics,* another points them to supplementary materials on the CD-ROM that accompanies the book, and a third signals the blackline masters and indicates their locations in the appendix.

which might reveal an important aspect of the information in the data. McClain, Cobb, and Gravemeijer (2000) describe some of their efforts at using computer tools to allow students to examine different aspects of a data set quickly. Those tools seemed to influence how the students thought about the data and about the answer to the question posed. The tools appeared to help students be more flexible at using data to answer a question that they saw as reasonable and important.

The use of technology in interrogating data can also reveal students' subtle misunderstandings. For example, making different kinds of graphs is easy with graphing software, so students are often observed making all possible graphs. They often have little concern for whether a particular graph is appropriate for the type of data under study. They might, for instance, generate a histogram for categorical data such as eye color. Teachers can take advantage of such "teachable moments" to explore why some graphs are appropriate and some are inappropriate. In this example, the categorical data do not extend over an entire interval, so it is inappropriate to create a histogram for such data. Learning from such mistakes is an effective way for students to develop good metacognitive skills, such as monitoring their work for accuracy and appropriateness.