MAKING SENSE OF STATISTICAL STUDIES

Teacher's Module

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Printed in the United States of America
10 9 8 7 6 5 4 3 2 1

978-0-9791747-6-6

Library of Congress Cataloging-in-Publication Data

Peck, Roxy.
Making sense of statistical studies / Roxy Peck, Daren Starnes ; with Henry Kranendonk, June Morita.
p. cm.
ISBN 978-0-9791747-6-6 (alk. paper)
1. Mathematical statistics--Study and teaching (Secondary)--United States. I. Starnes, Daren S. II. Title.
QA276.18.P43 2009
519.5--dc22
2009009395

I AM HONORED TO WRITE THE FOREWORD FOR *MAKING SENSE OF STATISTICAL STUDIES*, a capstone experience for high-school students. As statistics is increasingly recognized as a necessary component of the high-school mathematics curriculum and other high-school curricula, there is an urgent need for materials such as *MSSS*.

In its *Principles and Standards for School Mathematics* (*PSSM*, 2000), the National Council of Teachers of Mathematics (NCTM) articulates a vision for mathematics education that includes data analysis and probability as one of five major content strands. To support and further elaborate on the Data Analysis and Probability standard, the American Statistical Association (ASA) produced the report *Guidelines for Assessment and Instruction in Statistics Education (GAISE): A Pre-K–12 Curriculum Framework*. The goals of the GAISE Report include the following:

Presenting the statistics curriculum for grades Pre-K–12 as a cohesive and coherent curriculum strand

Promoting and developing statistical literacy

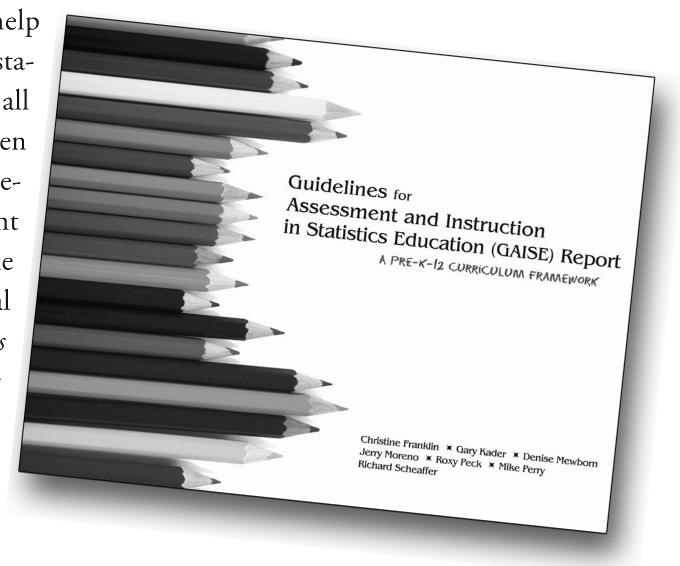
Providing links to the NCTM Standards

Articulating the differences between mathematical and statistical thinking—in particular, the importance of context and variability with statistical thinking

Clarifying the role of probability in statistics

Illustrating concepts associated with the data analysis process

The GAISE Report was endorsed by the ASA in 2005 and, with funding provided by the ASA/NCTM Joint Committee on Curriculum in Statistics and Probability, appeared in print in 2007.



The GAISE Framework was developed to help identify the essential topics and concepts in statistics and probability in grades pre-K–12 for all students as they progress from pre-kindergarden to graduation from high school. The Framework has become an instrumental document in defining the role of statistics within the school mathematics curriculum in national documents such as *College Board Standards for College Success: Mathematics and Statistics* (2006) and NCTM's forthcoming report *Focus in High School Mathematics: Reasoning and Sense-Making* (2009). The GAISE Report provides guidance for curriculum directors, faculty of teacher preparation colleges, and pre-K–12 teachers involved with statistics education. Finally, GAISE has had an effect on state standards and writers of assessment items. For example, the data analysis and probability strand is a major component of the new Georgia Mathematics Performance Standards.

The GAISE Report submits that every high-school graduate should be able to use sound statistical reasoning to intelligently cope with the requirements of citizenship, employment, and family and to be prepared for a healthy and productive life. It also holds that statistics is a must-have competency for high-school graduates to thrive in this modern world of mass information. Taken together, *PSSM* and the GAISE Report describe statistical problem solving as an investigative process that involves the following four components:

Formulate a question (or questions) that can be addressed with data

Design and employ a plan for collecting data

Analyze and summarize the data

Interpret the results from the analysis and answer the question on the basis of the data

The GAISE Report outlines a conceptual structure for statistics education in a two-dimensional framework model with one dimension defined by the statistical problem solving process, plus the nature of variability. The second dimension is comprised of three levels of statistical development (Levels A, B, and C), which students must progress through to develop statistical thinking. Grade ranges for attainment of each level are intentionally unspecified. It is paramount for students to have worthwhile experiences at Levels A and B during their elementary and middle-school years in order to prepare for future development at Level C during the secondary level. A high-school student with no prior experience with statistics will need experiences with concepts from both Levels A and B before moving to Level C.

Making Sense of Statistical Studies is an excellent set of investigations that supports the spirit of the GAISE Framework recommendations and is ideal for a capstone experience of the high-school student who has evolved through Levels A and B and is on to Level C. The investigations in *MSSS* bring the real world to the student and provide students the opportunity to understand the necessity of statistical reasoning and sense-making for everyday life and post-secondary education.

I'm most grateful to the writers of *MSSS* and the ASA/NCTM Joint Committee for developing this valuable resource in support of both the recommendations of GAISE and the importance of statistical reasoning in our high-school curriculum. These dear colleagues share the vision of promoting statistical reasoning for all high-school graduates.

Christine Franklin
Chair of the GAISE Report for Grades Pre-K–12

Preface

Making Sense of Statistical Studies (*MSSS*) is designed as a stand-alone experience with the methods of designing and analyzing statistical studies. It is written for an upper middle-school or high-school audience having some background in exploratory data analysis and basic probability.

The *MSSS* student module consists of an introduction and four distinct sections. Each section begins with an overview that contains essential background information for students. The remainder of the section is devoted to guided student investigations. These investigations start with a research question on some topic of interest. Students are then led through a series of questions that help them examine the study design, analyze data, and interpret results. Later investigations ask students to design, carry out, and analyze results from their own studies. A description of each section follows.

The **Introduction** gives students a snapshot of the statistical problem-solving process. It includes a brief discussion of the primary methods of data production—surveys, experiments, and observational studies—as well as the difference between a sample and a population. Ethical issues involved in data collection are also mentioned here.

Section I: Observational Studies shows students how much can be learned just by watching and recording data. The first two investigations in this section help students review the primary graphical and numerical tools for analyzing data. The remaining investigations incorporate random selection, which allows students to generalize the results of their data analysis to some larger population of interest.

Section II: Surveys begins with two investigations that require students to examine data from surveys and critique the design of surveys that have already been conducted. The questions include a review of some basic ideas of probability. In the final investigation of this section, students are led through the process of administering their own survey.

Section III: Experiments starts with an investigation in which students practice using the terminology of experiments as they review the details of two studies involving dieting and weight loss. In the next investigation, students are guided through the process of designing an experiment to test the effect of listening to music on memory. Once they have collected the data, students must use the data analysis and interpretation skills they developed in Section I to help answer the research question. Students get to design, execute, and analyze results from their own experiments in the final investigation of this section.

Section IV: Drawing Conclusions introduces students to the basic ideas of inference—estimating a population characteristic and testing a claim about a population characteristic. Simulation is used to quantify the sample-to-sample variability that occurs in repeated random sampling. This chance variation is reflected in the margin of error for an estimate and in the decision-making process for evaluating the validity of a claim about some population characteristic.

Acknowledgements

We would like to thank the American Statistical Association (ASA) for its steady support over the past five years as we have worked on this project. The initial funding for *MSSS* came from an ASA Member Initiative. With the publication of the GAISE Report, the ASA took a leadership role in promoting statistical literacy in the pre-K–12 mathematics curriculum. *MSSS* is designed to support the curriculum framework proposed in the GAISE Report.

Our special thanks go to the ASA/NCTM Joint Committee on Curriculum in Statistics and Probability (JC) for its unwavering commitment to making *MSSS* a reality. At a key point in the project, the JC provided additional funding that allowed the lead authors to meet for three uninterrupted days of writing. Under the leadership of Jerry Moreno, the JC also assisted in reviewing drafts of the student and teacher modules to get *MSSS* into production. We offer a heartfelt thank you to our colleagues who served as reviewers: Martha Aliaga, Brad Hartlaub, Dan Lotesto, Deborah Lurie, Jerry Moreno, Tom Short, and Jeff Witmer.

We particularly wish to acknowledge the contribution of Wanda Bussey and her students from Rufus King High School in Milwaukee, Wisconsin, as well as the students from Katedralskolan in Lund, Sweden, for the survey and data provided in Investigation #15.

Two individuals deserve our heartfelt appreciation for their tireless efforts during the final stages of the project. Nicholas Horton managed all aspects of the production process with remarkable professionalism. His close attention to detail and personal touch were essential in resolving many last-minute issues. Last, but certainly not least, Valerie Snider from the ASA deftly coordinated all elements of the design and production process. Her creative flair and passion for the project is apparent in the final publications. For those late nights and long weekends, and for her uncanny ability to meet seemingly impossible deadlines, we owe Val our sincere gratitude.

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