Contents

Foreword v

Preface vii

Introduction 1

Why Statistics? 1
Understanding Statistical Concepts 2
Big Ideas and Essential Understandings 3
Benefits for Teaching, Learning, and Assessing 4
Ready to Begin 5

Chapter 1 7
Statistics: The Big Ideas and Essential Understandings

Big Ideas and Associated Understandings 8
The big ideas in brief 8
The complete list of ideas and understandings 10
The Nature of Statistical Models: Big Idea 1 13
Mathematical models describe structure 14
Statistical models include variation 17
Good models give useful descriptions of structure 18
Describing Variability: Big Idea 2 24
Variability in a population 25
Approximating population distributions 29
Variability in the values of a sample statistic 32
Approximating sampling distributions 34
The Logic of Hypothesis Testing: Big Idea 3 44
Choosing between a null and an alternative hypothesis 45
Determining the alternative hypothesis 47
Convincing evidence against the null hypothesis 49
A measure of surprise 52
A risk of error 54
The Importance of the Data Collection Method: Big Idea 4 57
Observational studies and controlled experiments 57
Random assignment 61
Random selection 64
Implications of random selection and random assignment 65
Evaluating Estimators: Big Idea 5 67
The quality of estimators 68
Potential bias in estimators 69
Precision based on standard error and bias 71
Confidence intervals as estimators 74
Precision depends on sampling method and sample size 78

Sample size 80
Good methods trump large samples 83
Small samples despite large populations 85
Conclusion 87

Chapter 2 89
Connections: Looking Back and Ahead in Learning

Differences between Statistics and Mathematics 89
Informal to Semiformal to Formal Reasoning 90
Reasoning Related to Each Big Idea 91
The growth of Big Idea 1 91
The growth of Big Idea 2 92
The growth of Big Idea 3 93
The growth of Big Idea 4 93
The growth of Big Idea 5 94
Conclusion 95

Chapter 3 97
Challenges: Learning, Teaching, and Assessing

Going beyond Computational Fluency..... 97
Producing Good Statistics Questions..... 99
Assessing Interpretation and Conceptual Understanding..... 102
The Data Analysis Process—Culminating Assessments..... 107
Conclusion..... 107

Appendix 1 109
Glossary of Statistical Terms

Appendix 2 114
Resources for Teachers

References..... 120