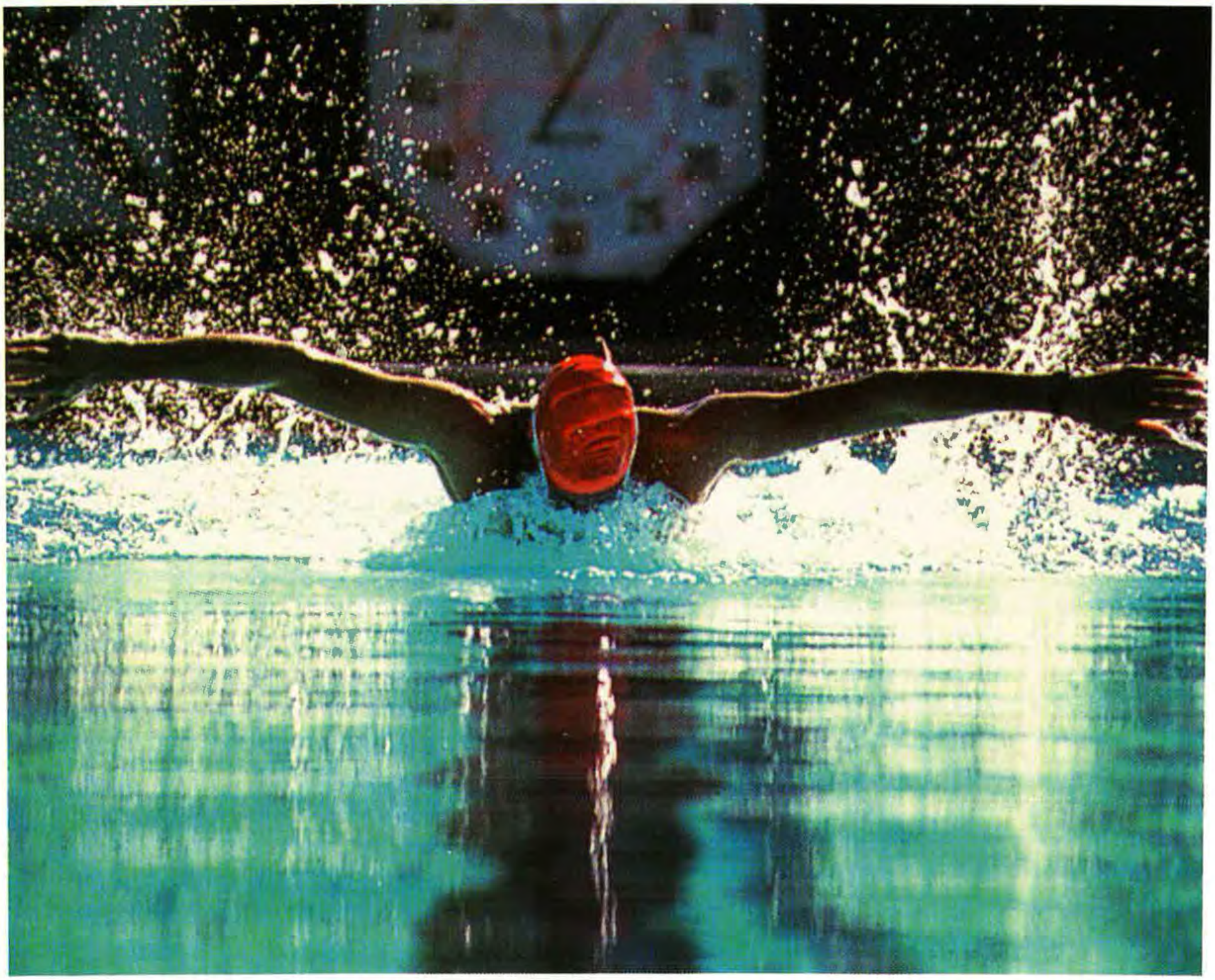
ALGEBRA

TEACHER'S EDITION

Exploring Projects

ERRTHUM, MASTROMATTEO, O'CONNOR, SCHEAFFER

DATA-DRIVEN MATHEMATICS



DALE SEYMOUR PUBLICATIONS®

Exploring Projects: Planning and Conducting Surveys and Experiments

TEACHER'S EDITION

DATA-DRIVEN MATHEMATICS

Emily Errthum, Maria Mastromatteo, Vince O'Connor, and Richard Scheaffer

Dale Seymour Publications®
White Plains, New York

This material was produced as a part of the American Statistical Association's Project "A Data-Driven Curriculum Strand for High School" with funding through the National Science Foundation, Grant #MDR-9054648. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Managing Editor: Alan MacDonell
Senior Mathematics Editor: Carol Zacny
Project Editor: Nancy R. Anderson
Production Manufacturing Director: Janet Yearian
Senior Production Coordinator: Fiona Santoianni
Design Manager: Jeff Kelly
Text and Cover Design: Christy Butterfield
Cover Photo: Uniphoto, Inc.

This book is published by Dale Seymour Publications®, an imprint of Addison-Wesley Longman, Inc.

Dale Seymour Publications
10 Bank Street
White Plains, NY 10602
Customer Service: 800-872-1100

Order number DS21165

ISBN 1-57232-398-1

1 2 3 4 5 6 7 8 9 10-ML-02 01 00 99 98

This Book Is Printed
On Recycled Paper

DALE
SEYMOUR
PUBLICATIONS®

Authors

Emily Errthum
Homestead High School
Mequon, Wisconsin

Richard Scheaffer
University of Florida
Gainesville, Florida

Maria Mastromatteo
Brown Middle School
Ravenna, Ohio

Vince O'Connor
Milwaukee Public Schools
Milwaukee, Wisconsin

Consultants

Jack Burrill
National Center for Mathematics
Sciences Education
University of Wisconsin-Madison
Madison, Wisconsin

Henry Kranendonk
Rufus King High School
Milwaukee, Wisconsin

Pat Hopfensperger
Homestead High School
Mequon, Wisconsin

Jeffrey Witmer
Oberlin College
Oberlin, Ohio

Data-Driven Mathematics Leadership Team

Gail F. Burrill
National Center for Mathematics
Sciences Education
University of Wisconsin-Madison
Madison, Wisconsin

Kenneth Sherrick
Berlin High School
Berlin, Connecticut

Richard Scheaffer
University of Florida
Gainesville, Florida

James M. Landwehr
Bell Laboratories
Lucent Technologies
Murray Hill, New Jersey

Miriam Clifford
Nicolet High School
Glendale, Wisconsin

Acknowledgments

The authors would like to thank the following people for their assistance during the preparation of this module:

- The many teachers who reviewed drafts and participated in the field tests of the manuscripts
- The members of the *Data-Driven Mathematics* leadership team, the consultants and writers
- Nancy Kinard, for her advice and suggestions in the early stages of the writing
- Kathryn Rowe and Wayne Jones for their help in organizing the field-test process and the Leadership Workshops

Table of Contents

Teacher Resources

About *Data-Driven Mathematics*

Historically, the purposes of secondary-school mathematics have been to provide students with opportunities to acquire the mathematical knowledge needed for daily life and effective citizenship, to prepare students for the workforce, and to prepare students for postsecondary education. In order to accomplish these purposes today, students must be able to analyze, interpret, and communicate information from data.

Data-Driven Mathematics is a series of modules meant to complement a mathematics curriculum in the process of reform. The modules offer materials that integrate data analysis with high-school mathematics courses. Using these materials helps teachers motivate, develop, and reinforce concepts taught in current texts. The materials incorporate the major concepts from data analysis to provide realistic situations for the development of mathematical knowledge and realistic opportunities for practice. The extensive use of real data provides opportunities for students to engage in meaningful mathematics. The use of real-world examples increases student motivation and provides opportunities to apply the mathematics taught in secondary school.

The project, funded by the National Science Foundation, included writing and field testing the modules, and holding conferences for teachers to introduce them to the materials and to seek their input on the form and direction of the modules. The modules are the result of a collaboration between statisticians and teachers who have agreed on the statistical concepts most important for students to know and the relationship of these concepts to the secondary mathematics curriculum.

A diagram of the modules and possible relationships to the curriculum is on the back cover of the Teacher's Edition.

Using This Module

Why the Content Is Important

The most important application of mathematics today for a large part of the population involves both the collection and the analysis of data. Thus, students need to have some experience in this area while in high school. Projects, however, are not trivial, and the process of conducting a project is usually not taught. The lessons in this module lead students step by step through the process of creating and carrying out a survey or an experiment. The lessons develop the overall framework and key components, such as the use of random sampling, that are necessary for a successful project. As they work through a project on a single theme or topic of interest to them, students tie together the major areas of statistical work: problem formulation, data collection, data analysis, and data interpretation. In the process, they gain practical experience in working on a team, organizing field work, and managing data.

Exploring Projects: Planning and Conducting Surveys and Experiments is made up of four units.

Unit I deals with conducting a *census*. The exercises help students understand what a census is. The U.S. Census is discussed specifically as perhaps the most important and most well-known census.

Unit II gives information about *sample surveys*. After a discussion of the need to do sample surveys, the concepts of *bias* and *randomization* are explained and exercises are given that help to clarify these concepts. The need to critically read the results of sample surveys is stressed. Enrichment is offered for those students ready to deal with the concept of sampling error. At the end of the unit, ideas for student surveys are suggested along with a sample survey plan.

Unit III focuses on conducting *experiments*. The concepts of *variability* and *bias* are once again stressed as students investigate how questions can be answered through experiments. Suggestions for simple experiments that can be carried out by the class are given at the end of the unit.

Unit IV helps the student to complete a *project* of his or her own. There is a lesson that gives specific directions about conducting student projects. There are exercises that show how the same information can be graphically displayed in several ways. A reference lesson reminds students of the types of graphical displays they can use and gives information on how to make them. There is also a reference lesson that reminds the student of the writing process.

Mathematical Content

- representations of data in tables and graphs
- percentages, proportions, and rates
- elementary probability
- estimation

Statistical Content

- census
- sample survey: questionnaire design, randomization, data management, estimating population quantities
- experiment: treatment, control, randomization, data management, drawing conclusions
- inferences and conclusions
- bias

Instructional Model

The instructional emphasis in *Exploring Projects: Planning and Conducting Surveys and Experiments,* as in all of the modules in *Data-Driven Mathematics,* is on discourse and student involvement. Each lesson is designed around a problem or a mathematical situation and begins with a series of introductory questions or scenarios that can be used to prompt discussion and raise issues about that problem. These questions can provoke students' involvement in thinking about the problem and help them understand why such a problem might be of interest to someone outside the classroom.

Once the stage has been set for the problem, students begin to investigate the situation mathematically. As students work their way through the investigations, it is important that they have the opportunity to share their thinking with others and to discuss their solutions in small groups and with the whole class. Many of the exercises are designed for groups, in which each member of the group does one part of the problem and the results are compiled for a final analysis and solution. Multiple solutions and solution strategies are also possible, and it is important for students to recognize these situations and to discuss the reasoning that leads to different approaches. Each student thus is provided with a broad base upon which to build his or her own understanding of the mathematics.

In many cases, students are expected to construct their own understanding by thinking about the problem from several perspectives. They do need, however, validation of their thinking and confirmation that they are on the right track, which is why discourse among students and between students and teacher is critical. In addition, an important part of the teacher's role is to help students understand the concepts within an investigation and to provide an overview of the "big picture" of the mathematics within the investigation. To facilitate this, a review and formalization of the mathematics is presented in a summary following each unit and within some lessons.

Teacher Resources

At the back of this Teacher's Edition are the following:

- Assessment Ideas with sample Evaluation Sheets
- Quizzes
- Solutions to Quizzes
- Activity Sheets
- The 1990 Census Questionnaire

Use of Teacher Resources

These items are referenced in the *Materials* section at the beginning of the lesson commentaries.

LESSON	**RESOURCE MATERIALS**
Unit I: Censuses	
Lesson 1: Conducting a Census	• The 1990 Census Questionnaire
Unit I Activity: Taking Your Own Census	• Activity Sheet 1 • Unit I Quiz
Unit II: Surveys	
Lesson 5: Selecting a Sample	• Activity Sheet 2
Lesson 6: Studying Randomization	• Activity Sheets 2 and 3
Unit II Activity: Conducting Your Own Survey	• Activity Sheet 4 • Unit II Quiz
Unit III: Experiments	
Lesson 12: Measurement Variability and Bias	• Activity Sheet 5
Activity: Conducting Your Own Experiment	• Unit III Quiz
Unit IV: Projects	
Lesson 15: Doing a Project	• Activity Sheets 6–10 • Assessment Ideas: Evaluation Sheets

Where to Use the Module in the Curriculum

Depending upon the mathematical content of the projects, this module could be used anywhere in the curriculum from general classes in the middle school to statistical-studies classes in the high school. Some of the activities involve more background knowledge than others, but all can be modified for a given class.

Student projects can be assigned at any level of mathematical sophistication and need not wait until the student has studied formal statistical procedures. The time allotted to complete a project can range from a few weeks to an entire term, and projects can be assigned concurrently with the study of other mathematics.

You do not need to start at page one in this book and proceed to the end. Each unit can stand alone. If your goal as a teacher is to have your students conduct sample surveys, you may use just that unit. Also, you can complete many of the lessons independently of the others. For example, if your goal is to have students read critically, then you should use Lesson 7, "Sampling in the Real World," and Lesson 8, "Critiquing a Printed Article."

Prerequisites

Students should have worked with ratios and percents and should be familiar with stem-and-leaf plots, box plots, and graphing points in a plane. For those who might need review, a possible resource is *Exploring Data* by Landwehr and Watkins, Dale Seymour Publications, 1995.

Pacing/Planning Guide

The table lists objectives and provides a possible sequence and pacing of the lessons.

LESSON	OBJECTIVES	PACING
Unit I: Censuses		
Exploratory Lesson: Collecting and Analyzing Data	Give students a brief introduction to first three sections of this module.	1/2 class period
Lesson 1: Conducting a Census	Recognize a census and give some of its characteristics. Address problems associated with taking a census.	1 class period or more
Lesson 2: Looking at the U.S. Census	Recognize the uses of U.S. census data. Calculate population increase and decrease. Understand population density and how it is calculated.	1 class period
Activity: Taking Your Own Census	Demonstrate through hands-on experience aspects of planning, conducting, and reporting a census.	1 class period or more
Unit II: Surveys		
Lesson 3: Conducting a Survey	Recognize a sample survey. Design a sample survey.	1 class period
Lesson 4: Asking Questions	Learn to minimize bias in constructing survey questions.	1 class period or less
Lesson 5: Selecting a Sample	Apply randomization in sample selection. Recognize and analyze sampling bias.	1 class period
Lesson 6: Studying Randomization	Recognize that randomization reduces sampling bias.	2 class periods or less
Lesson 7: Sampling in the Real World	Understand how surveys are conducted in the real world. Find similarities and differences among real-world surveys. Use proportions and percents to make comparisons.	1 class period
Lesson 8: Critiquing a Printed Article	Critically analyze surveys reported in the real world. Use proportions and percents to make comparisons. Read a graph.	1 class period
Lesson 9: Understanding Sampling Error	Identify characteristics of sampling error. Compute sampling error.	1 class period
Activity: Conducting Your Own Survey	Practice designing and conducting surveys.	1 class period or more

LESSON	OBJECTIVES	PACING
Unit III: Experiments		
Lesson 10: Conducting an Experiment	Conduct an experiment, and reflect on the results. Analyze data for clusters, gaps, and outliers. Make graphs from collected data.	1 class period
Lesson 11: Experimenting to Answer a Question	Design and conduct an experiment to answer specific questions.	1 class period
Lesson 12: Measurement Variability and Bias	Understand that all measurement processes are subject to variability and bias. Estimate lengths and measure in inches and quarter inches. Graph and interpret collected data.	1 class period
Lesson 13: Experiments in the Real World	Appreciate how experiments are conducted. Recognize how results are used in the real world. Calculate percents and proportions, standard deviation of a sample proportion, and confidence intervals.	1 class period
Activity: Conducting Your Own Experiment	Design, implement, and analyze the results of an experiment.	1 class period or more
Unit IV: Projects		
Lesson 14: A Reference Guide	Use a reference guide as a tool when working on individual projects.	1 class period
Lesson 15: Doing a Project	Complete a project following correct procedure.	1 week to entire semester
Lesson 16: Representing the Same Data in Different Ways	Organize data in many different forms for clearer understanding. Construct a box plot. Read and interpret a graphical display. Compute and compare percents.	1 class period or more
Information Sheet: Informing Others	Write effective reports.	teacher's discretion
		approximately 4 to 5 weeks total time

Technology

Technology can vary according to the level of the students and the level of the projects. Computers with graphing software, graphing calculators, and word processors would be advisable to use for the projects, but are certainly not necessary. Some lessons do require at least a four-function calculator.

Grade Level/Course

This module is appropriate for students in grades 7–12. The scope of the project can vary in difficulty depending on the class level.

UNIT I

Censuses

EXPLORATORY LESSON

Collecting and Analyzing Data

Materials: none
Technology: none
Pacing: 1/2 class period

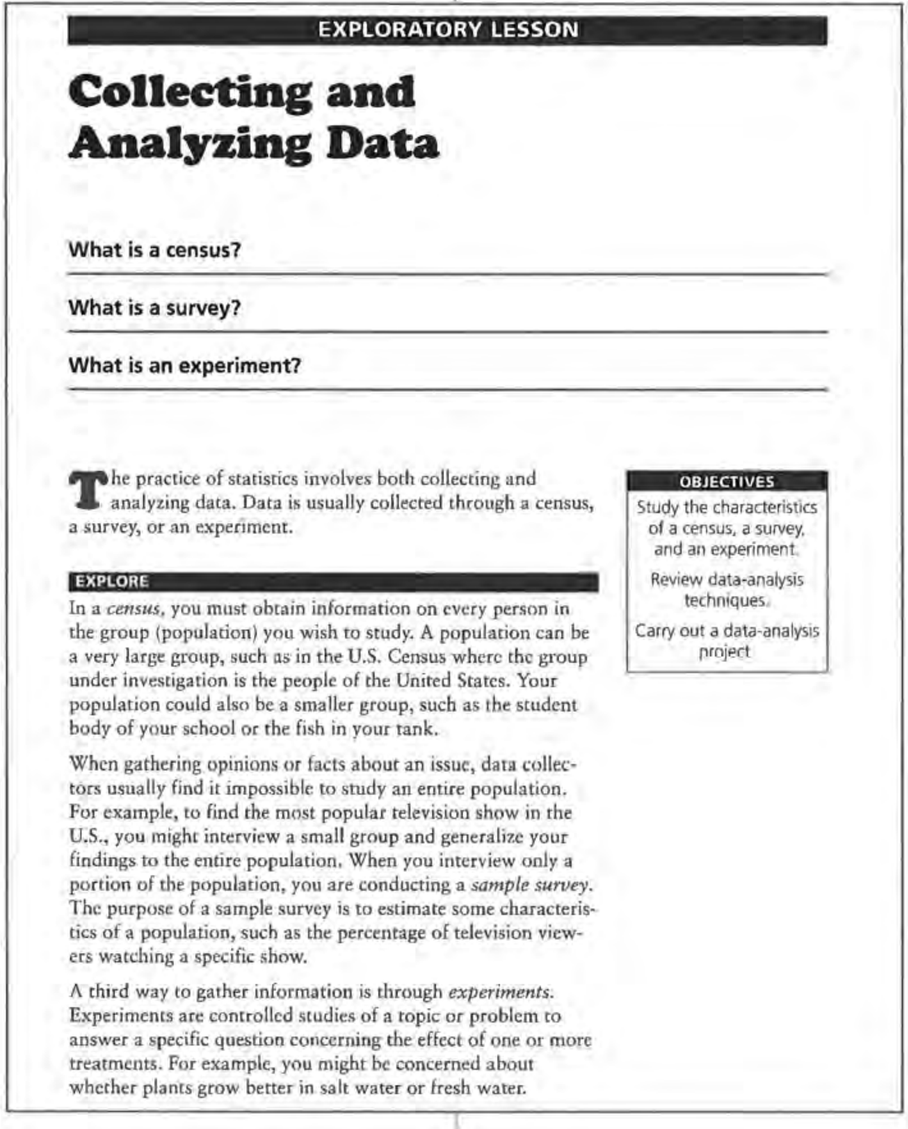
Overview

This lesson is designed to give students a brief introduction to the first three units of the module: Censuses, Surveys, and Experiments. It explains the three ways to collect data and has students read short articles or look at graphs to tell whether what they have read or inspected is a census, a survey, or an experiment. As the lessons progress, students will learn in more detail how to distinguish the three collection methods and how to design their own censuses, surveys, and experiments.

Teaching Notes

You might facilitate the lesson by assigning the reading as homework. It would be very helpful if students could get into groups to read the articles or to look at the graphs and then determine how to classify each article or graph as a census, a survey, or an experiment. Another approach is to divide the class into five groups and let each group study one of the selections. Each group should describe its article and draw a conclusion as well as explain its decision. Students might begin collecting articles from the media that could be used later as examples of censuses, surveys, and experiments.

STUDENT PAGE 3



EXPLORATORY LESSON

Collecting and Analyzing Data

What is a census?

What is a survey?

What is an experiment?

The practice of statistics involves both collecting and analyzing data. Data is usually collected through a census, a survey, or an experiment.

OBJECTIVES

Study the characteristics of a census, a survey, and an experiment.

Review data-analysis techniques.

Carry out a data-analysis project.

EXPLORE

In a *census*, you must obtain information on every person in the group (population) you wish to study. A population can be a very large group, such as in the U.S. Census where the group under investigation is the people of the United States. Your population could also be a smaller group, such as the student body of your school or the fish in your tank.

When gathering opinions or facts about an issue, data collectors usually find it impossible to study an entire population. For example, to find the most popular television show in the U.S., you might interview a small group and generalize your findings to the entire population. When you interview only a portion of the population, you are conducting a *sample survey*. The purpose of a sample survey is to estimate some characteristics of a population, such as the percentage of television viewers watching a specific show.

A third way to gather information is through *experiments*. Experiments are controlled studies of a topic or problem to answer a specific question concerning the effect of one or more treatments. For example, you might be concerned about whether plants grow better in salt water or fresh water.

Solution Key

Investigate

1. The article "Exercising Options" is a survey. The population was high-school students. Of the population, 11,631 students were surveyed.
2. The article "Love is Not Blind, and Study Finds it Touching" is an experiment. Information given in the article explains how this experiment was carried out. The goal is to decide if loved ones can be identified by touch; the goal is not to estimate some population characteristic.

STUDENT PAGE 4

Throughout this module, you will study these three methods of collecting data. You will discover important ideas that will help you analyze studies and determine if a survey or an experiment is accurate. You will look at surveys and experiments that experts have done, and you may design and carry out a survey or an experiment of your own.

Your class will tie together a full menu of statistical ideas including problem formation, data collection, data analysis, and data interpretation—all built around a theme that interests you.

Data Collection and Analysis

Read the following articles and graphs and determine whether each is a census, a survey, or an experiment.

1. Exercising Options

High school kids are exercising less, with almost equal numbers sweating over a game of Nintendo as a game of basketball.

Around 37 percent of high school students surveyed say they exercise vigorously and regularly, according to a Center for Disease Control and Prevention study. But 35 percent say they spend at least three hours a day watching TV or playing video games. The study, based on a survey of 11,631 high school students from 124 schools nationwide, did find that this percentage declined as students got older. Boys were consistently more active than girls in all age categories. And girls became increasingly less active as they grew older—31 percent of ninth graders said they exercised three or more times a week, while only 17.3 percent of twelfth graders made the same claim.

Source: *NEA Today*, February, 1995

2. Love is not Blind, and Study Finds it Touching

How well do lovers know each other? A new study suggests that if blindfolded, they might recognize each other just by feeling their partners' foreheads. And if he's a man, touching his hand might do.

Seventy-two blindfolded people in the study tried to distinguish their romantic partner from two decoys of similar age, weight and height.

The blindfolded participants stroked the back of each person's right hand in one test, and the forehead in another. Each time, they were asked to pick out the lover.

Random guessing would be right 33 percent of the time. But the blindfolded people were correct 58 percent of the time in the forehead test, and women identified their man's hand 69 percent of the time.

3. The graph "Women Off and Running" is a census because all women running for U.S. House seats and gubernatorial races were counted.

4. The article "If Women Ran America" is a sample survey. A poll was used by *Life* magazine to gather the information.

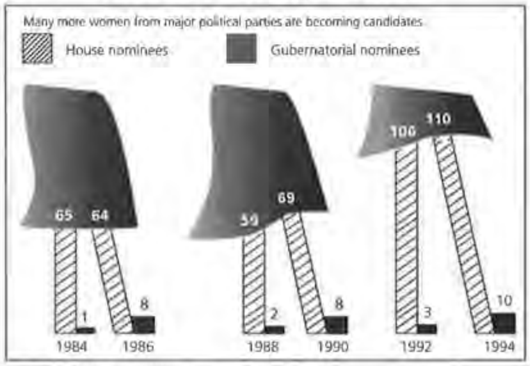
STUDENT PAGE 5

"I think that in real life we could probably do a whole lot better" said researcher Marsha Kaitz. The stress of being in a laboratory experiment and the carefully matched decoys probably hindered the real-world ability of recognition by touch, she said.

"I think that probably everyone can do it," Kaitz, a psychologist at Hebrew University in Jerusalem, said in a telephone interview. Touch recognition is "just a skill that has not been tapped before," she said.

Source: *Associated Press*, June 22, 1992

3. Statistics That Change the Nation



Source: data from National Women's Political Caucus, 1994

4. If Women Ran America

Two sexes differ on the issues affecting the nation.

NEW YORK—A poll comparing men's and women's attitudes on public issues suggests women want stricter law enforcement against drunken driving, guns and drug dealing.

The poll was commissioned by *Life* magazine for a story in the June issue headlined "If Women Ran America." *Life* said its poll found women interested in "safety first. But fairness also, especially fairness for women at work."

Two in three women polled said they consider unequal pay for the same work to be a very serious problem for women in the workplace. Just half the men responded similarly.

Half the women but only a third of the men think discrimination in promotions is a very serious problem for women at work.

The poll said 78 percent of women, compared with 64 percent of men, think businesses should be required to provide paid maternity leave.

5. The article "Back Treatment: Lay Off" is really just observation about a particular population. It is neither a true experiment nor a true survey.

STUDENT PAGE 6

The poll was taken by the Gallup Organization, which surveyed a national sample of 614 women and 608 men by phone March 30–April 5.

The margin of error ranges from plus or minus 3 percentage points for the whole sample, up to 6 points for comparisons of results of men and women.

In other words, the poll indicates a gender gap, rather than chance variation, accounts for differences of opinion such as this: 55 percent of women but only 46 percent of men said the government should make fighting crime and violence an extremely important priority.

Seventy-six percent of women and only 58 percent of men said the justice system wasn't hard enough on drunken drivers. On drug dealing, 88 percent of women and 77 percent of men wanted the system to be tougher. Seventy percent of women and 63 percent of men wanted to be tougher on illegal gun possession.

Women were more compassionate than men on some issues: 85 percent would approve of a law requiring businesses to allow employees an unpaid 12-week family medical leave. Women were more likely than men to approve of such a leave for homosexual couples, and to say they would vote for a gay candidate.

Source: *Gainesville Sun*, May 5, 1992

5. Back Treatment: Lay Off

By Tim Friend, *USA Today*

Less may be best when it comes to treating back pain.

A study out today suggests that people whose doctors prescribe the least pain medicine or physical restriction get as much relief as those treated with more pain medicine and bed rest.

The researchers, writing in the Annals of Internal Medicine, studied 1,213 people with back pain and the 44 doctors who treat them at the Group Health Cooperative of Puget Sound, Seattle.

They divided doctors into groups—those prescribing the most medicine and rest, those in the middle, and those prescribing the least. Outcomes of patients one and two years after the initial visit reveal:

- No difference in how patients rated their care, and none in their level of pain.
- Those who took the least medicine and restriction were the most satisfied with efforts to each them how to deal with pain.
- Total cost of care was 79% higher in patients prescribed the most medicine and bed rest.
- About 85% of people have back pain at some time, making it the second leading reason to see a doctor, behind colds.

Source: *USA Today*, 1993

LESSON 1

Conducting a Census

Materials: none
Technology: search tools and CD ROMS (optional)
Pacing: 1 class period or more

Overview

When most people hear the word *census,* they think of the U.S. Census that is conducted every ten years. This lesson asks students to discuss their knowledge of the census. It also deals with the difficulties involved in taking the census. The problems involved in collecting information from an entire population are highlighted. The overall focus of this lesson is on general knowledge of the census. Students should understand that a census need not deal with the total population of the United States. It is a census if any entire subsection of the population is surveyed.

For example, if you want information on all the students in your school and you call everyone and get the required information, you have a census on the population of students. The difficulty, however, is getting responses from the entire population, which is a focus of this lesson.

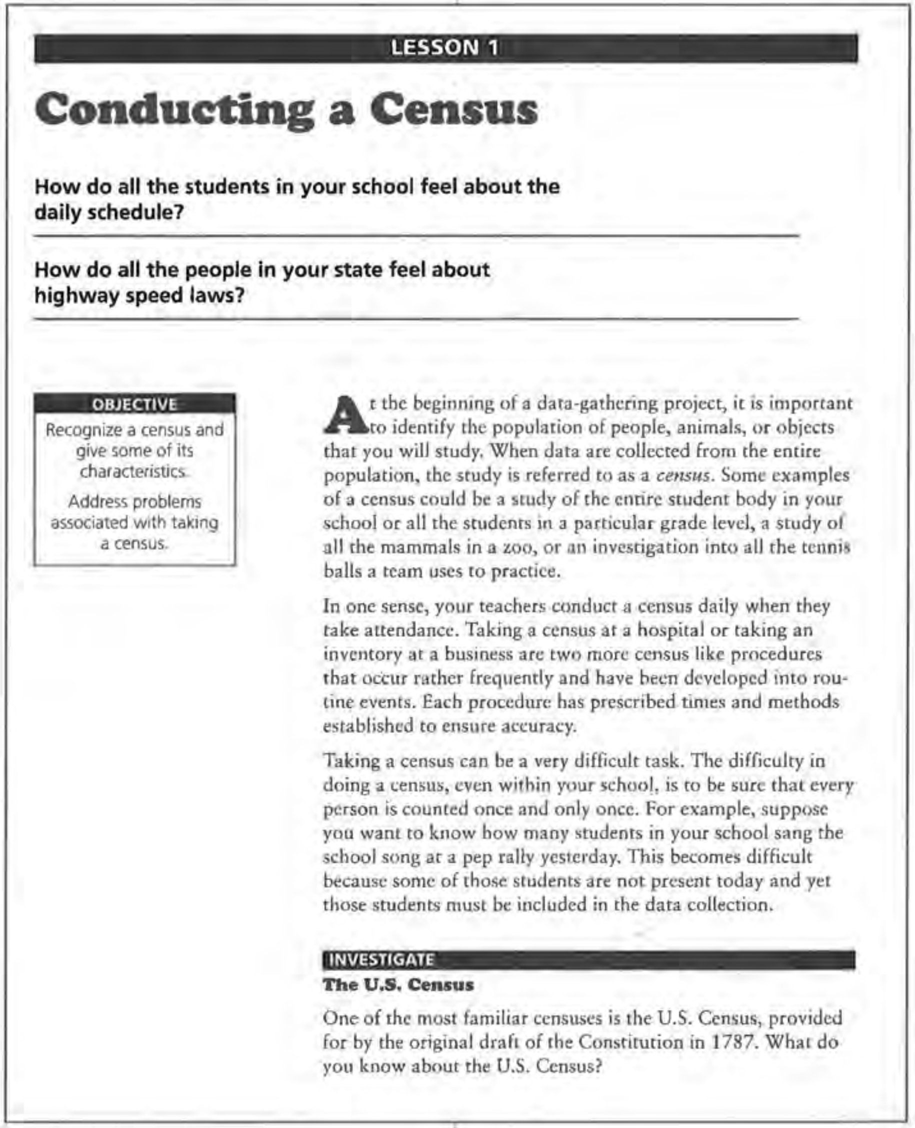
Teaching Notes

You may wish to bring in a school census used to determine how many students of school age the community will have during the next year. Discuss with students why the school system needs such information. Other censuses may be available from the city or regional offices, or from religious organizations.

A population undercount is a serious matter for large urban areas. If too many of the population are not counted, the funds allocated for financial assistance and for health and police services are reduced. Authorities strive to find better and more efficient methods to ensure that everyone is counted. In the 1990 census, the technique employed was similar to the Capture/Recapture problem in *Exploring Surveys and Information from Samples,* Landwehr and Watkins, Dale Seymour, 1986.

You may want to have groups of students do some brief research on the U.S. Census and then present their findings for Problems 1–5 to the class. Individuals or groups could also brainstorm answers for Problems 6–8 and then present their ideas to the class. Students could use search tools and CD ROMS to obtain more information about the U.S. Census.

STUDENT PAGE 7



LESSON 1

Conducting a Census

How do all the students in your school feel about the daily schedule?

How do all the people in your state feel about highway speed laws?

OBJECTIVE

Recognize a census and give some of its characteristics.

Address problems associated with taking a census.

At the beginning of a data-gathering project, it is important to identify the population of people, animals, or objects that you will study. When data are collected from the entire population, the study is referred to as a *census*. Some examples of a census could be a study of the entire student body in your school or all the students in a particular grade level, a study of all the mammals in a zoo, or an investigation into all the tennis balls a team uses to practice.

In one sense, your teachers conduct a census daily when they take attendance. Taking a census at a hospital or taking an inventory at a business are two more census like procedures that occur rather frequently and have been developed into routine events. Each procedure has prescribed times and methods established to ensure accuracy.

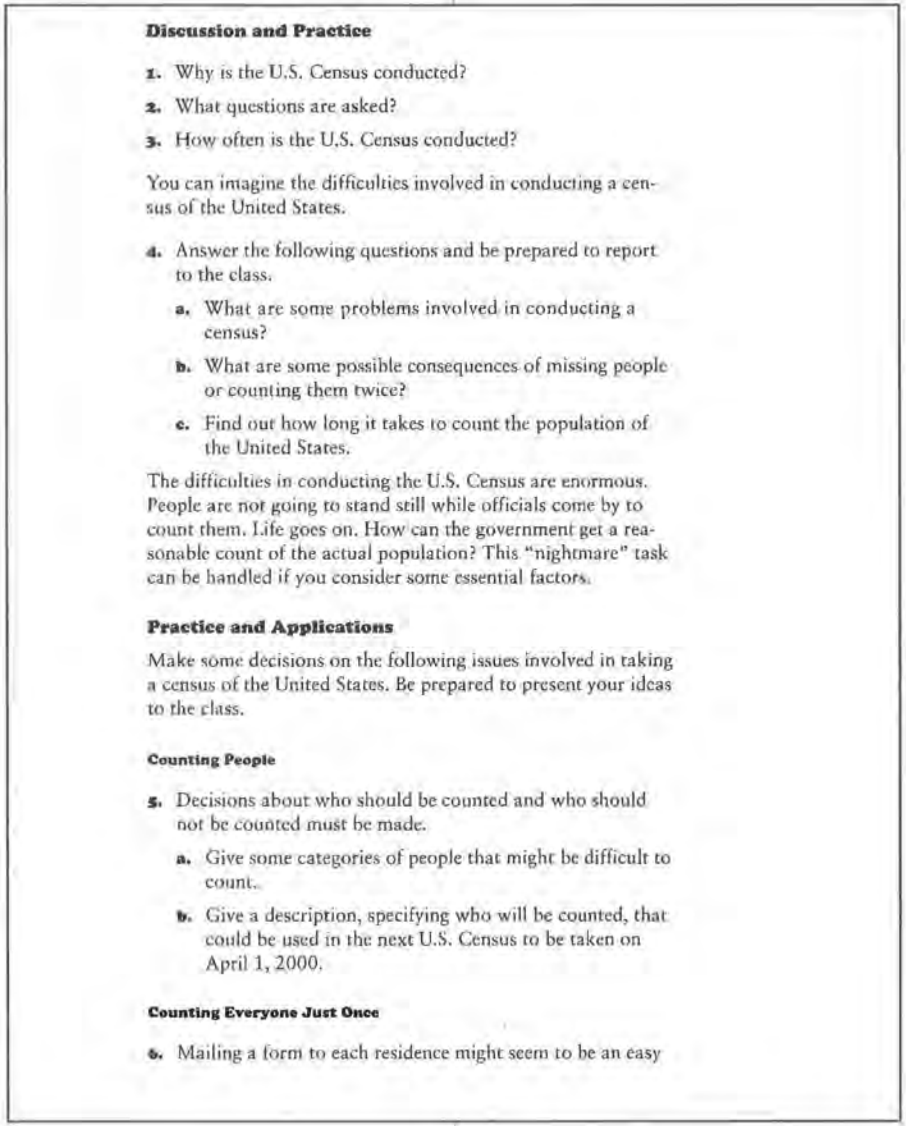
Taking a census can be a very difficult task. The difficulty in doing a census, even within your school, is to be sure that every person is counted once and only once. For example, suppose you want to know how many students in your school sang the school song at a pep rally yesterday. This becomes difficult because some of those students are not present today and yet those students must be included in the data collection.

INVESTIGATE

The U.S. Census

One of the most familiar censuses is the U.S. Census, provided for by the original draft of the Constitution in 1787. What do you know about the U.S. Census?

STUDENT PAGE 8



Discussion and Practice

1. Why is the U.S. Census conducted?
2. What questions are asked?
3. How often is the U.S. Census conducted?

You can imagine the difficulties involved in conducting a census of the United States.

4. Answer the following questions and be prepared to report to the class.
   a. What are some problems involved in conducting a census?
   b. What are some possible consequences of missing people or counting them twice?
   c. Find out how long it takes to count the population of the United States.

The difficulties in conducting the U.S. Census are enormous. People are not going to stand still while officials come by to count them. Life goes on. How can the government get a reasonable count of the actual population? This "nightmare" task can be handled if you consider some essential factors.

Practice and Applications

Make some decisions on the following issues involved in taking a census of the United States. Be prepared to present your ideas to the class.

Counting People

5. Decisions about who should be counted and who should not be counted must be made.
   a. Give some categories of people that might be difficult to count.
   b. Give a description, specifying who will be counted, that could be used in the next U.S. Census to be taken on April 1, 2000.

Counting Everyone Just Once

6. Mailing a form to each residence might seem to be an easy

Solution Key

Discussion and Practice

1. Answers will vary but the following are typical reasons why the U.S. Census is conducted.
   - to determine the number of Representatives each state is allotted in Congress
   - to find out about the standard and the quality of living of U.S. citizens
   - to determine income levels to better distribute funds to communities for programs such as education
   - to determine Congressional, state, and local election district boundaries
   - to find out how many elderly people there are
   - to determine the need for transportation, medical, and educational facilities
2. To find out what types of questions are asked on the Census, see *The 1990 Census Questionnaire* included at the end of this Teacher's Edition.
3. The U.S. Census is taken every ten years in the decade years, 1970, 1980, and so on.
4. **a.** Some of the problems involved in conducting the U.S. Census are including everyone, getting accurate responses, and collecting and recording data correctly.

   b. Consequences of inaccurate data can alter or halt projects and can cause federal, state, or local funds to be allocated unfairly. Being missed in the count can affect the people missed as well as their neighbors.

   c. Census population counts for each state must reach the president within nine months after Census Day, which has been April 1 of the Census year since 1930.

Practice and Applications

5. **a.** People who might be difficult to count are soldiers at home or overseas, travelers, U.S. citizens who work abroad, people who are born or die on Census Day, college students, homeless individuals, and so on.

b. Answers will vary.

6. **a.** Some difficulties with mailing a questionnaire are recording people who move, who own more than one home, or who are homeless.

b. Answers will vary.

7. **a.** If one city or state had several thousand more people than were counted in the Census, it would have more representatives in Congress and more funding for education, service, and other programs at the expense of those regions in which the count was accurate.

b. Answers will vary.

c. Answers will vary.

STUDENT PAGE 9

and accurate task, but there are difficulties with this procedure as well.

a. List some difficulties in counting people by mailing a form.

b. Write a paragraph explaining how you would count everyone just once.

Controlling Errors

7. Following up on incomplete questionnaires, missing questionnaires, and other sources of error is an important feature of the U.S. Census effort.

a. Many political decisions are made by using the data the census provides. What are some of those decisions? How would errors affect them?

b. What other errors might occur?

c. How would you check for errors and locate missing questionnaires?

8. Extend Design a census you could use to count the number of people living on your block on April 1 of next year. Be sure your questionnaire makes clear exactly who should be counted.

LESSON 2

Looking at the U.S. Census

Materials: none
Technology: calculators
Pacing: 1 class period

Students could work individually or in small groups to do the calculations and to answer the questions.

Overview

This lesson takes a closer look at one of the uses of the U.S. Census—determining population density. The effects of population density and its percent of increase are key factors when discussing the Census. They are also important mathematical ideas placed in a real context.

You may wish to share *The 1990 Census Questionnaire* with your students as additional information.

Teaching Notes

Students can use this lesson as a stepping stone to research on the Census. Background information about the Census—its history, its purpose, and its procedures—is given below. Students can use the media center to find out about the Census and do either oral or written reports on it. The first known census was given for tax purposes in Babylonia in 3800 b.c. The following is a brief history of the U.S. Census. The resource is *Educator's Guide to the 1990 Census,* from the U.S. Department of Commerce, Bureau of the Census, August 1988.

> The need for a national census of the new United States arose soon after the thirteen colonies broke their ties with Great Britain. The costs of the Revolutionary War (1775–83) had been high, and the new nation had to find ways to pay the debt; one way was to divide it equally among the people. Another reason for a census was to establish a truly representative government to sit in the two Houses of Congress. While each state, regardless of size, would have two Senators in the Senate, the number of Members of the House of Representatives would be apportioned—divided up—among the states according to their population. The only way to find out how many people there were was to count them, so for the first time in history, a nation decided to make a census part of its constitution. As adopted in 1787, the U.S. Constitution included these words in Article I, Section 2:
>
> > "Representatives and direct Taxes shall be apportioned among the several States which may be included with this Union, according to their respective Numbers . . . . The actual Enumeration shall be made within three Years after the first Meeting of the Congress of the United States, and within every subsequent Term of ten Years, in such Manner as they shall by Law direct."
>
> From its beginnings, the decennial census has been more than a simple "headcount." Gathering information on sex and age in 1790 was done "undoubtedly, to obtain definite knowledge as to the military and industrial strength of the country." Through the years, the nation has changed and so has the decennial census. The size, composition, and distribution of the population; the laws; and the complexity of the country have changed—and with them, the needs for statistical information. To stay in step, the content of the census has varied over time, "in such Manner as they shall by Law direct." Since 1940, the decennial census has been limited to items on population and housing.

To summarize the growing number of census returns, mechanical tallying machines were first introduced in the 1870 census. Despite their presence, publishing all the reports from the 1880 census took nearly a decade. These growing processing problems led directly to the development of the punch card and an electric tabulating machine by Herman Hollerith, an employee of what was then called the U.S. Census Office. This revolutionary means of coding and tallying information was used to process the 1890 census.

The first commercial electronic computer, UNIVAC-1, was used to compile some of the statistics from the 1950 census . . . . Dealing with ever-increasing processing complexities, Census Bureau employees created another revolutionary machine known as FOSDIC (Film Optical Sensing Device for Input to Computers) for use in tabulating the 1960 census. After high-speed cameras microfilm census questionnaires, FOSDIC reads the "fill-in-the-dot" answers directly onto computer tape. To enhance accuracy in collecting and tabulating census information, the 1990 census will be [was] marked by the Census Bureau's creation of a new digital mapping and geographic referencing system known as TIGER (Topologically Integrated Geographic Encoding and Referencing).

It was only in 1902 that a permanent census office was established in the Interior Department. In 1903 it was transferred to the new Department of Commerce and Labor. When that department was split in 1913, the Bureau of the Census was placed in the Department of Commerce.

Census population counts for each state must be reported to the President within 9 months after Census Day, which has been April 1 of the census year since 1930. Within 1 week of the opening of the next session of the Congress, the President must send to the Clerk of the House of Representatives the census count for each state and the number of Representatives to which each state is entitled, following the method of apportionment selected by the Congress. Within 15 calendar days, the Clerk of the House then notifies the Governor of each state how many Representatives that state will be entitled to in the next Congress . . . .

While the Census Bureau is best known for the national Census of population and Housing conducted every 10 years, the agency also conducts national agriculture, economic, and governments censuses every 5 years. Besides censuses, the Census Bureau administers about 250 sample surveys each year (many for other Federal agencies) and prepares estimates and projections. These data collection efforts result in thousands of statistical reports each year. All of this has earned the Census Bureau the name Fact Finder for the Nation.

The following information from the same source answers some more specific questions about the Census.

> *How was the 1990 Census taken?*
>
> Just before the day of the Census, most households in the United States received a questionnaire in the mail. Census workers delivered other questionnaires to rural areas and to some urban, multifamily complexes. The Census asked 95% of the households to mail the completed form right away. If they didn't, a Census worker went to that home to get the information. The rest of the Census included people in sparsely settled rural areas and in group quarters—such as nursing homes, college dormitories, military barracks, and boarding houses. A Census-taker either picked up forms from these places or did interviews there. A completed form included information about everyone that lived at the house except visitors. Babies born on the day of the Census were included.
>
> *What happened then?*
>
> Returned forms were checked for completeness. If Census employees saw that information was missing, illegible, or inconsistent, they contacted the household to correct the form. After making these checks, the employees tallied the answers to the same questions from all the forms. This created statistical totals for a variety of geographic areas.
>
> *What was asked?*
>
> Most of the questionnaires asked only a limited number of questions about each household member—such as race, national origin, age, and marital

status—and about the house unit—such as owner or renter status. It took about 15–20 minutes to complete. The remaining households completed more elaborate forms that asked about education, employment, income, occupation, ancestry, the age of the building, the source of water, the type of fuel used for heating, and so on. The average completion time for this form was about 45 minutes. A sampling pattern selected these households. Their responses were very important because they statistically depicted the total population on items such as education. The Census used the sampling method to minimize demands made on the public, but still get useful and reliable data.

How are the Census summary data used?

The questionnaires included only questions that addressed important policy and program needs. For instance, questions on plumbing facilities provided data for Federal studies on housing standards and quality. Likewise, summary statistics from the income questions were widely used by Federal, state, local, Native American tribal, and Alaskan Native village governments in the distribution of funds to communities for a variety of programs, including education. The 1990 population totals were used to determine Congressional, state, and local election district boundaries.

Governments draw heavily on census data in planning and implementing community projects and developments, such as planning for new schools. Business and industry make use of these statistics, especially those for small geographic areas, to decide where to build new plants or offices. Social-service providers are increasingly using Census data to understand and help their clientele. The 1980 Census Neighborhood Statistics Program made Census information available for approximately 28,000 neighborhoods, giving community leaders a better understanding of their areas. Individuals also use Census-summary information for personal decisions, such as planning a small business or choosing a place to live. By law, the personal information collected by the Census cannot be given to anyone or any organization. Much more information is available through the Bureau of the Census.

Students could work individually or in small groups to do the calculations and to answer the questions.

Follow-Up

You may want to invite a speaker from the Bureau of the Census Department to give a presentation about the department to your class. If you write to the Census Department and include your zip code and your county, they will send you a report of statistics for your community. These statistics can suggest very interesting projects for the class.

Bureau of the Census
Department of Commerce
Washington, D.C. 20233

Solution Key

Discussion and Practice

1. Population density is important for economic reasons, such as housing, water consumption, food supply, and air purity.

STUDENT PAGE 10

LESSON 2

Looking at the U.S. Census

What kind of information is collected by the U.S. Census?

Why is it collected?

Who uses the information?

OBJECTIVE

Recognize the uses of U.S. Census data. Calculate population increase and decrease. Understand population density and how it is calculated.

U.S. Census data provide a wealth of information. These data help determine housing needs, state and local funding, education levels, and gender- and race-equity issues. They are also valuable for making predictions and forecasting events: where people are moving; how many elderly people will be in the United States in ten years; and how many new schools will be needed. Census data are used to report changes in population after each decade. These data also determine the number of representatives each state has in Congress and the amount of funds states receive for federal programs, such as grants for low-cost housing.

INVESTIGATE

Population Density

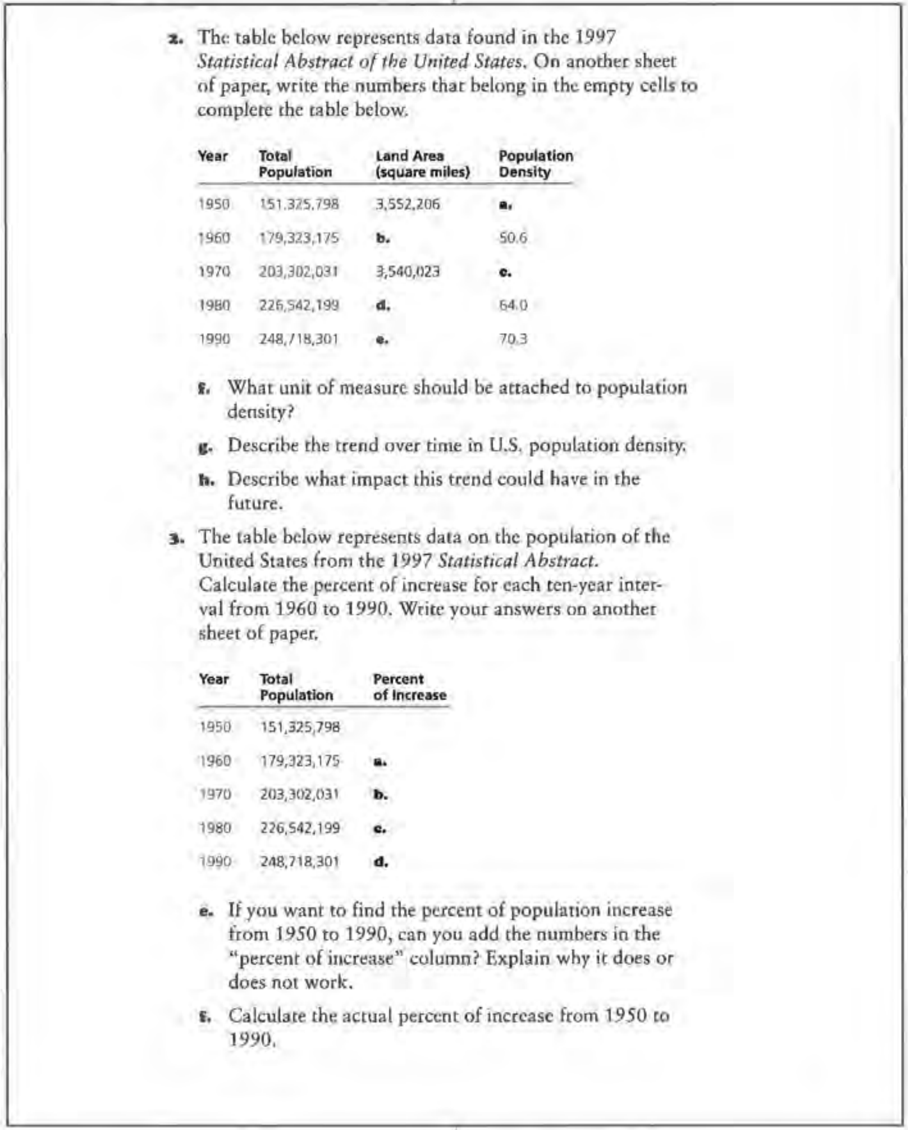
Census data can be used to study *population density.* Population density is the average number of people living in a specified unit of area. The density is calculated by dividing the number of people in the population by the area covered by that population.

Discussion and Practice

1. Why do you think population density might be an important issue?

STUDENT PAGE 11

2. See table below.



2. The table below represents data found in the 1997 *Statistical Abstract of the United States*. On another sheet of paper, write the numbers that belong in the empty cells to complete the table below.

Year	Total Population	Land Area (square miles)	Population Density
1950	151,325,798	3,552,206	**a.**
1960	179,323,175	**b.**	50.6
1970	203,302,031	3,540,023	**c.**
1980	226,542,199	**d.**	64.0
1990	248,718,301	**e.**	70.3

f. What unit of measure should be attached to population density?

g. Describe the trend over time in U.S. population density.

h. Describe what impact this trend could have in the future.

3. The table below represents data on the population of the United States from the 1997 *Statistical Abstract*. Calculate the percent of increase for each ten-year interval from 1960 to 1990. Write your answers on another sheet of paper.

Year	Total Population	Percent of Increase
1950	151,325,798	
1960	179,323,175	**a.**
1970	203,302,031	**b.**
1980	226,542,199	**c.**
1990	248,718,301	**d.**

e. If you want to find the percent of population increase from 1950 to 1990, can you add the numbers in the "percent of increase" column? Explain why it does or does not work.

f. Calculate the actual percent of increase from 1950 to 1990.

Year	Total Population	Land Area (square miles)	Population Density
1950	151,325,798	3,552,206	**a.** 42.6
1960	179,323,175	**b.** 3,543,936	50.6
1970	203,302,031	3,540,023	**c.** 57.4
1980	226,542,199	**d.** 3,539,722	64.0
1990	248,718,301	**e.** 3,537,956	70.3

f. The unit of measure that should be used with population density is "people per square mile."

g. The population density of the United States in increasing.

h. Increased population density could cause shortages in food, water, natural resources, and clean air. More money must be appropriated to cover cost of education, cost of caring for the elderly, or the cost of transportation in densely populated regions.

3.

Year	Total Population	Percent of Increase
1950	151,325,798	
1960	179,323,175	**a.** 18.5%
1970	203,302,031	**b.** 13.4%
1980	226,542,199	**c.** 11.4%
1990	248,718,301	**d.** 9.8%

To calculate percent of increase for 1960, compute the following:

$$\frac{\text{1960 population} - \text{1950 population}}{\text{1950 population}}$$

e. You do not add the numbers in the percent increase column to determine the percent of population increase from 1950 to 1990. If you did, you would get 53.1% increase. The 1950 population of 151,325,798 and the 1990 population of 248,718,301 clearly indicate more than a 53.1% increase.

f. The actual increase from 1950 to 1990 is 64.4%.

$$\frac{\text{1990 population} - \text{1950 population}}{\text{1950 population}}$$

4. Answers will vary. Take the number of people in the class divided by the area of the room in square yards.

STUDENT PAGE 12

SUMMARY

- In a census, you must obtain information on every member of the population you are studying.
- The group you are interested in studying is called the *population*.
- The U.S. Census, which is conducted every ten years, is an official *enumeration*, or count, of the number of people living in the United States. It is used for political, social, and economic purposes.

Practice and Applications

4. Find the population density of your classroom or the school auditorium using the number of people per square yard.

UNIT I ACTIVITY

Taking Your Own Census

Materials: *Activity Sheet 1*
Technology: computers (optional), calculators (optional)
Pacing: 1 class period or more

Overview

This activity demonstrates to students through a hands-on experience many of the aspects of planning, conducting, and reporting a census of their own. It shows students what goes into the production of statistical information, how individual responses on a questionnaire are merged to create summary data, and the usefulness of the summarized information. Students will also be able to work with personally relevant data.

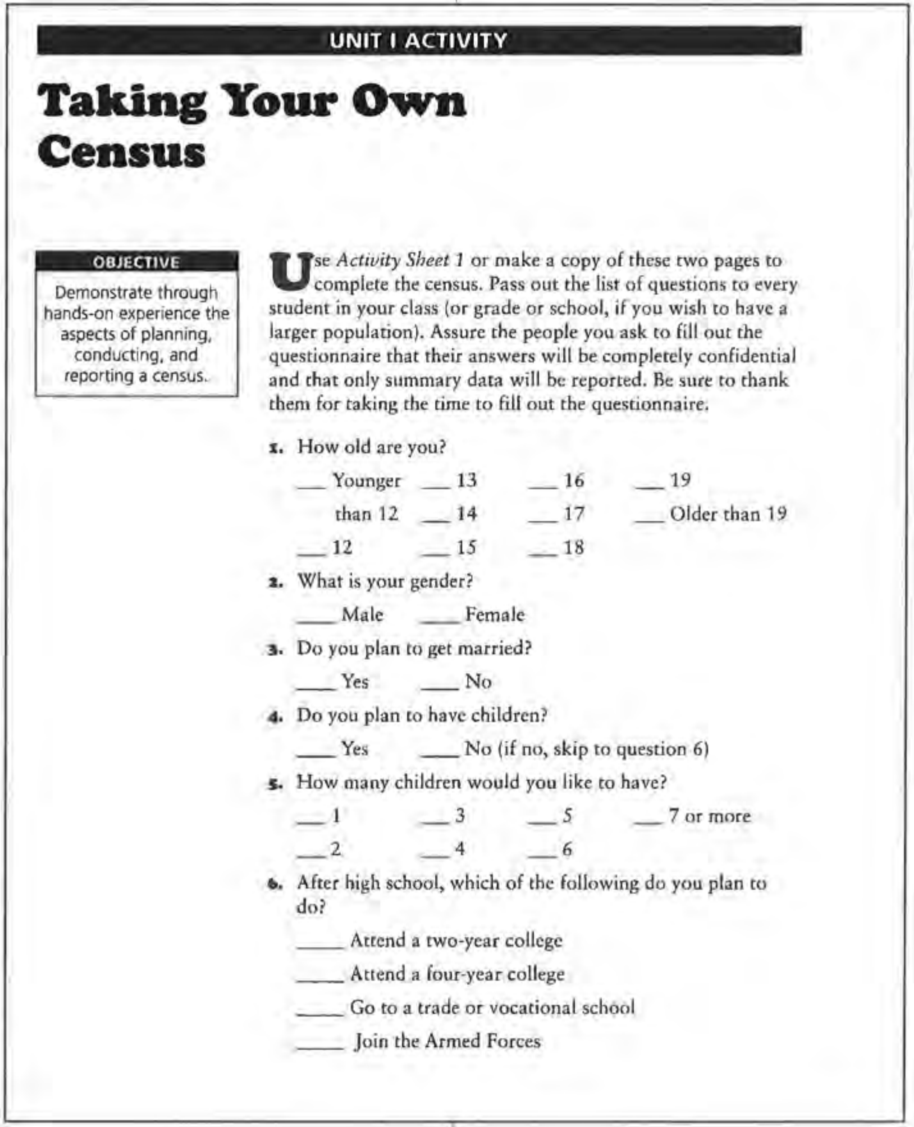
Teaching Notes

This material is from "That's Easy for You to Say!" by the Department of Commerce, Bureau of the Census, August 1988. Students can prepare their own census questionnaire and not use the one provided. One suggestion is to divide the class into committees to consider the separate aspects of the project—questionnaire design, data collection, and data processing. Each committee should have a decision leader and a scribe.

If students design their own questionnaires, they should only use about ten questions with answers that can be circled or checked, not filled in. Make sure they include two or three "background demographic" items, so students can correlate data and make statements such as, "The girls were more likely to say . . . ." Students who use computers to process the forms should sequentially number each form or record so they can reference them easily should coding errors or strange values appear.

The assessment aspect of this activity lies in how each student or group of students follows through on his or her assigned task. You'll find more information on assessment in the Assessment and Quizzes section at the end of this book.

STUDENT PAGE 13



UNIT I ACTIVITY

Taking Your Own Census

OBJECTIVE

Demonstrate through hands-on experience the aspects of planning, conducting, and reporting a census.

Use *Activity Sheet 1* or make a copy of these two pages to complete the census. Pass out the list of questions to every student in your class (or grade or school, if you wish to have a larger population). Assure the people you ask to fill out the questionnaire that their answers will be completely confidential and that only summary data will be reported. Be sure to thank them for taking the time to fill out the questionnaire.

1. How old are you?

___ Younger than 12 ___ 13 ___ 16 ___ 19
___ 12 ___ 14 ___ 17 ___ Older than 19
___ 15 ___ 18

2. What is your gender?

___ Male ___ Female

3. Do you plan to get married?

___ Yes ___ No

4. Do you plan to have children?

___ Yes ___ No (if no, skip to question 6)

5. How many children would you like to have?

___ 1 ___ 3 ___ 5 ___ 7 or more
___ 2 ___ 4 ___ 6

6. After high school, which of the following do you plan to do?

___ Attend a two-year college
___ Attend a four-year college
___ Go to a trade or vocational school
___ Join the Armed Forces

STUDENT PAGE 14

____ Get a full-time job

____ None of these

7. Of the following occupations, which one would you most like to pursue after school?

____ Doctor

____ Teacher

____ Social Worker

____ Lawyer

____ Computer Programmer

____ Stockbroker

____ Firefighter

____ Hairdresser

____ Mechanic

____ Carpenter

____ Truck Driver

____ Law Enforcement

____ Farmer

____ None of these

8. Of the following occupations, which one would you least like to pursue after school?

____ Doctor

____ Teacher

____ Social Worker

____ Lawyer

____ Computer Programmer

____ Stockbroker

____ Firefighter

____ Hairdresser

____ Mechanic

____ Carpenter

____ Truck Driver

____ Law Enforcement

____ Farmer

____ None of these

Source: "That's Easy for You to Say!" Department of Commerce, Bureau of the Census, August 1988

Once the questionnaire has been completed by every class member, you can begin to analyze your results. Decisions you will need to make are:

- How will you record the information you have gathered?
- Will you break into groups to analyze each question?
- How much time will you devote to this study?
- How will you communicate your results?

UNIT II

Surveys

LESSON 3

Conducting a Survey

Materials: none
Technology: none
Pacing: 1 class period

Overview

This lesson was designed so students understand that it is not easy to write good survey questions. Students will also practice analyzing and writing questions.

Teaching Notes

When students answer the questions on the initial survey, the responses will vary greatly. Some will answer in glasses, some in ounces, some in cans, and so on. Students will find when they attempt to collate these answers that there is no common measure, and some changes need to be made to the original survey questions. Students should work in small groups to complete this lesson.

Follow-Up

Students might practice writing a survey to find an answer to a question for which they have a special interest.

Solution Key

Discussion and Practice

1. Students should answer survey questions on a separate piece of paper.

STUDENT PAGE 17

LESSON 3

Conducting a Survey

In the last section, you learned about taking a census. Is it always possible to take a census?

If you have your blood tested, does the doctor use all of your blood for the test?

OBJECTIVES

Recognize a sample survey.

Design a sample survey.

Because taking a census is a difficult and sometimes impossible task, it is often necessary to take a portion of the population and to study that group. Collecting information from a portion of a group is referred to as a *sample survey*.

INVESTIGATE

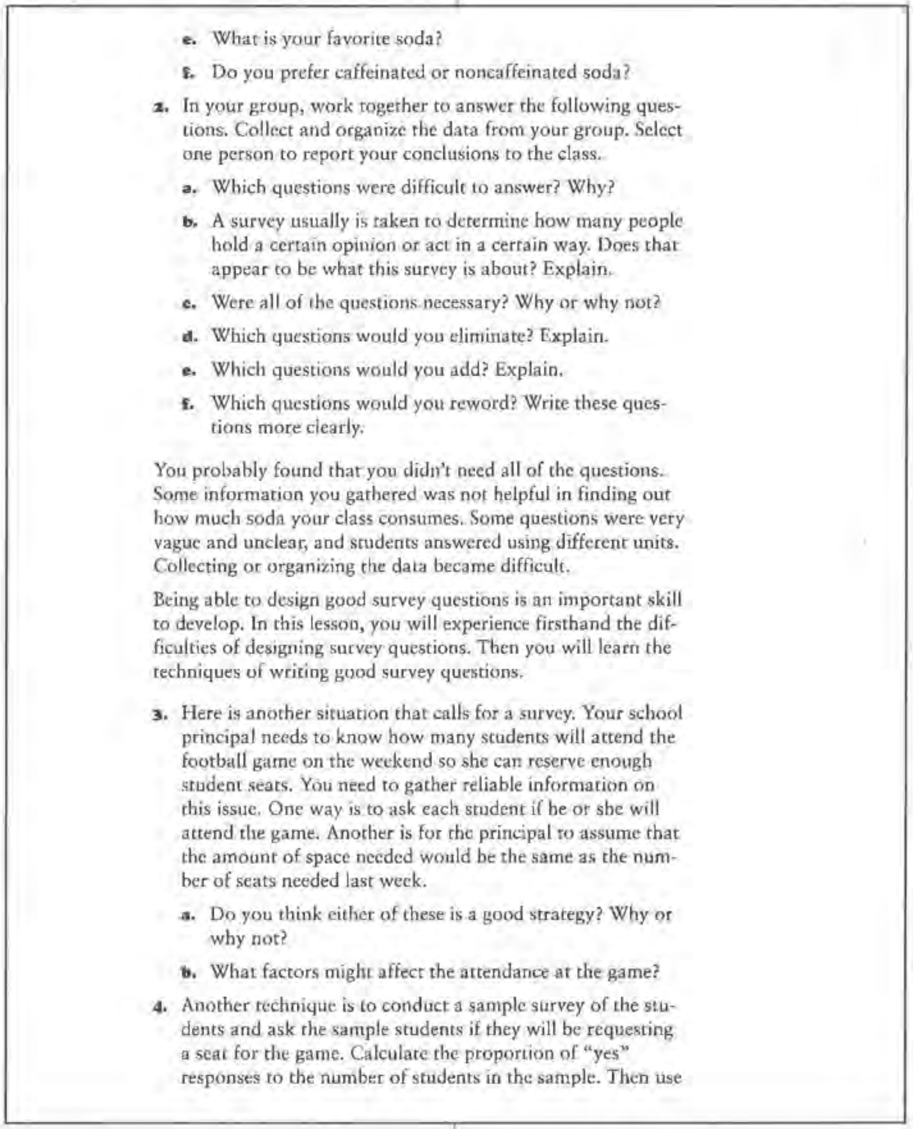
Survey Methods

Frequently, people want to gather opinions or facts about an issue or an idea. One method of gathering this information is to stop people at grocery stores, malls, bus stations, and so on, and to ask them the desired question(s). Another method is to call people on the phone. You or someone in your family may have answered sample-survey questions before.

Discussion and Practice

1. The survey below deals with soda (or soft-drink) consumption. It is a first attempt at designing survey questions. Your goal is to find out how much soda is consumed by your class. Individually, write a response to each of the following survey questions.
   a. What is your name?
   b. Are you male or female?
   c. How much soda do you drink?
   d. Are you an athlete or a nonathlete?

STUDENT PAGE 18



- **e.** What is your favorite soda?
- **f.** Do you prefer caffeinated or noncaffeinated soda?

2. In your group, work together to answer the following questions. Collect and organize the data from your group. Select one person to report your conclusions to the class.

- **a.** Which questions were difficult to answer? Why?
- **b.** A survey usually is taken to determine how many people hold a certain opinion or act in a certain way. Does that appear to be what this survey is about? Explain.
- **c.** Were all of the questions necessary? Why or why not?
- **d.** Which questions would you eliminate? Explain.
- **e.** Which questions would you add? Explain.
- **f.** Which questions would you reword? Write these questions more clearly.

You probably found that you didn't need all of the questions. Some information you gathered was not helpful in finding out how much soda your class consumes. Some questions were very vague and unclear, and students answered using different units. Collecting or organizing the data became difficult.

Being able to design good survey questions is an important skill to develop. In this lesson, you will experience firsthand the difficulties of designing survey questions. Then you will learn the techniques of writing good survey questions.

3. Here is another situation that calls for a survey. Your school principal needs to know how many students will attend the football game on the weekend so she can reserve enough student seats. You need to gather reliable information on this issue. One way is to ask each student if he or she will attend the game. Another is for the principal to assume that the amount of space needed would be the same as the number of seats needed last week.

- **a.** Do you think either of these is a good strategy? Why or why not?
- **b.** What factors might affect the attendance at the game?

4. Another technique is to conduct a sample survey of the students and ask the sample students if they will be requesting a seat for the game. Calculate the proportion of "yes" responses to the number of students in the sample. Then use

2. **a.** The questions in parts b and e were probably harder to answer because there were many possible ways to answer.

b. Yes, this survey seems to want to find out how many people drink a certain amount and type of soda.

c. Only the question in part b is needed to answer the question, "How much soda is consumed by your class?" The last few questions may be of interest, but they do not directly address the issue.

d. Students might eliminate the questions in parts d, e, and f because they do not directly deal with the main question.

e. Students might add questions that narrow the choices in amount of soda and that set a time frame for the questions.

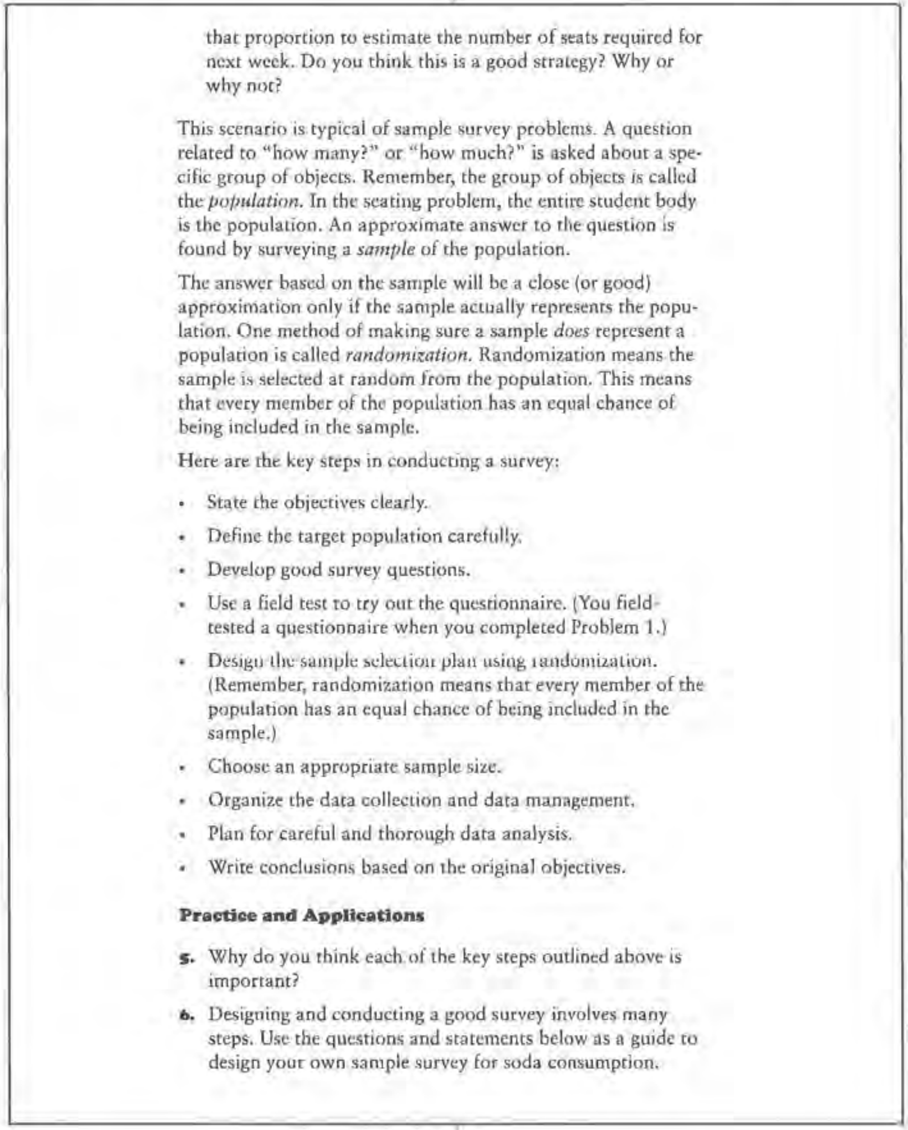
f. Although the second question addresses the main question, it is very vague. Students will use many units of measure, so collecting class data will be very difficult. Also, no time period was set, so answers could be vastly different. This questions should be reworded. Student rewrites of the questions will vary.

3. **a.** For a complete census, you would have to ask every student if he or she would attend the game. This would be very difficult. On the other hand, if the principal assumed the same number of students would attend the game as the week before, she is not taking into account factors such as who the opponent is or what the weather will be like. These would affect game attendance.

b. Factors that might affect next week's attendance include the weather, the opponent being played, and the time the game is played. Other things going on in the community might have an impact on attendance. Students may have other reasons.

4. This is a good technique, provided a random sample of students is selected and the sample size is at least 10% of the student body, as you will want to avoid small samples. Multiply the sample proportion who will request seats by the population size of the school to obtain the total number of seats needed.

STUDENT PAGE 19



that proportion to estimate the number of seats required for next week. Do you think this is a good strategy? Why or why not?

This scenario is typical of sample survey problems. A question related to "how many?" or "how much?" is asked about a specific group of objects. Remember, the group of objects is called the *population*. In the seating problem, the entire student body is the population. An approximate answer to the question is found by surveying a *sample* of the population.

The answer based on the sample will be a close (or good) approximation only if the sample actually represents the population. One method of making sure a sample *does* represent a population is called *randomization*. Randomization means the sample is selected at random from the population. This means that every member of the population has an equal chance of being included in the sample.

Here are the key steps in conducting a survey:

- State the objectives clearly.
- Define the target population carefully.
- Develop good survey questions.
- Use a field test to try out the questionnaire. (You field-tested a questionnaire when you completed Problem 1.)
- Design the sample selection plan using randomization. (Remember, randomization means that every member of the population has an equal chance of being included in the sample.)
- Choose an appropriate sample size.
- Organize the data collection and data management.
- Plan for careful and thorough data analysis.
- Write conclusions based on the original objectives.

Practice and Applications

5. Why do you think each of the key steps outlined above is important?

6. Designing and conducting a good survey involves many steps. Use the questions and statements below as a guide to design your own sample survey for soda consumption.

Practice and Applications

5. Each of these steps is integral to selecting a good sample.

- If the objective is not clear, the questions asked may not give you the information you are seeking.
- If the target population is not clear, members of a group other than the population of interest may be surveyed. This would invalidate the results because the responses may not be representative of the group in which you are interested.
- The questions must be clear and unbiased, and ask what you want to know. If this is not the case, the results of your survey will not answer the original question.
- The field test is important to see if you are getting responses that answer the question you are asking.
- The randomness of your sample, relative to the population, is very important. All segments of the population must have a chance to be in the sample to assure that the population is represented fairly.
- It is important to choose enough people in your sample to get a fair idea of what your population is thinking, but not too many people. You don't want to waste your time and money.
- There must be consistency in collection and management of data so there is accuracy in the results.
- Data analysis shows the results of your survey. Thoroughness and accuracy are most important to have accurate conclusions.
- Your conclusion should reflect all of the work done in the other eight steps of this process. It should be based on actual results and should answer the question you originally asked.

6. A possible survey might include the following:

a. We want to know how much soda is consumed by people who live in the homes of this class in one day and if their preferences are diet or regular soda.

b. Our target population is the people who live in the homes of the students in this class.

c. Sample questions: "How many 8-ounce glasses of soda do you drink in a day?" and "Do you prefer diet drinks?"

d. Students will try this survey out on people who live in their homes. When they write their paragraphs it is important to

- Make sure they use factual information from the data they gathered.
- Insist on correct grammar and spelling.
- Make sure they answer the questions as listed in Problem 4.

STUDENT PAGE 20

a. What is it you want to find out? State your question clearly.

b. Whom do you want to survey? Define the target population carefully.

c. Develop a few good questions. Remember, a survey often is taken to determine how many or how much. (How many people prefer diet drinks?) It may be that each question may only ask for an opinion. (Do you prefer diet drinks?) The questions must be clearly stated so the answers are as accurate as possible, and so the answers are comparable across the respondents. (Does *family* mean the same to everyone?)

d. Field-test your survey with five to ten people. Write a paragraph that tells how your survey worked. Indicate whether your questions were clear and had acceptable answers. What difficulties did you have? Proofread and correct grammar and spelling.

e. Conduct your survey and report your results.

LESSON 4

Asking Questions

Materials: none
Technology: none
Pacing: 1 class period or less

Overview

This lesson was designed so that students understand that the concept of bias is crucial when writing survey questions. The wording the questioner uses, the tone or manner of asking, or the tenor of the topic, may cause the respondent to give a response different from what he or she would give if the item were asked in a nonbiased way.

Teaching Notes

The issue of bias is a hot topic in contemporary America. This lesson will elicit many opinions from students. Discussion is important both in small groups and within the class as a whole.

STUDENT PAGE 21

LESSON 4

Asking Questions

How many people are in your family?

Would you prefer to have class in a large new building or in an old run-down school?

OBJECTIVE

Learn to minimize bias in constructing survey questions.

There are many things to watch for when creating a survey questionnaire. Questions need to be well-stated to get exactly the information you want. When the respondent does not understand the question, it may be that the question is ambiguous. In the question, "How many people are in your family?" the word *family* can be interpreted in many different ways. If the goal is to know how many family members are living in your home, you first have to agree on a definition of family. If the goal is to know how many brothers a person has, then the question might be, "How many living brothers and stepbrothers do you have?" You, as the survey designer, have to understand clearly what question you want to be answered.

INVESTIGATE

Bias in Surveys

Bias, too, is a very important issue that needs to be understood. Questions should not be asked in ways that influence their answers. If responses to a question tend to lean toward one side of the "truth," then the responses are said to be biased. For example, if the bathroom scale is set 5 pounds light, the measurements produced by the scale will be biased. Anyone who gets on the scale will see a reading that is on the light side of the truth.

Discussion and Practice

When analyzing statistics, bias can interfere with a true picture of what is happening in the population. You must minimize all types of bias. Here are some examples.

Solution Key

Discussion and Practice

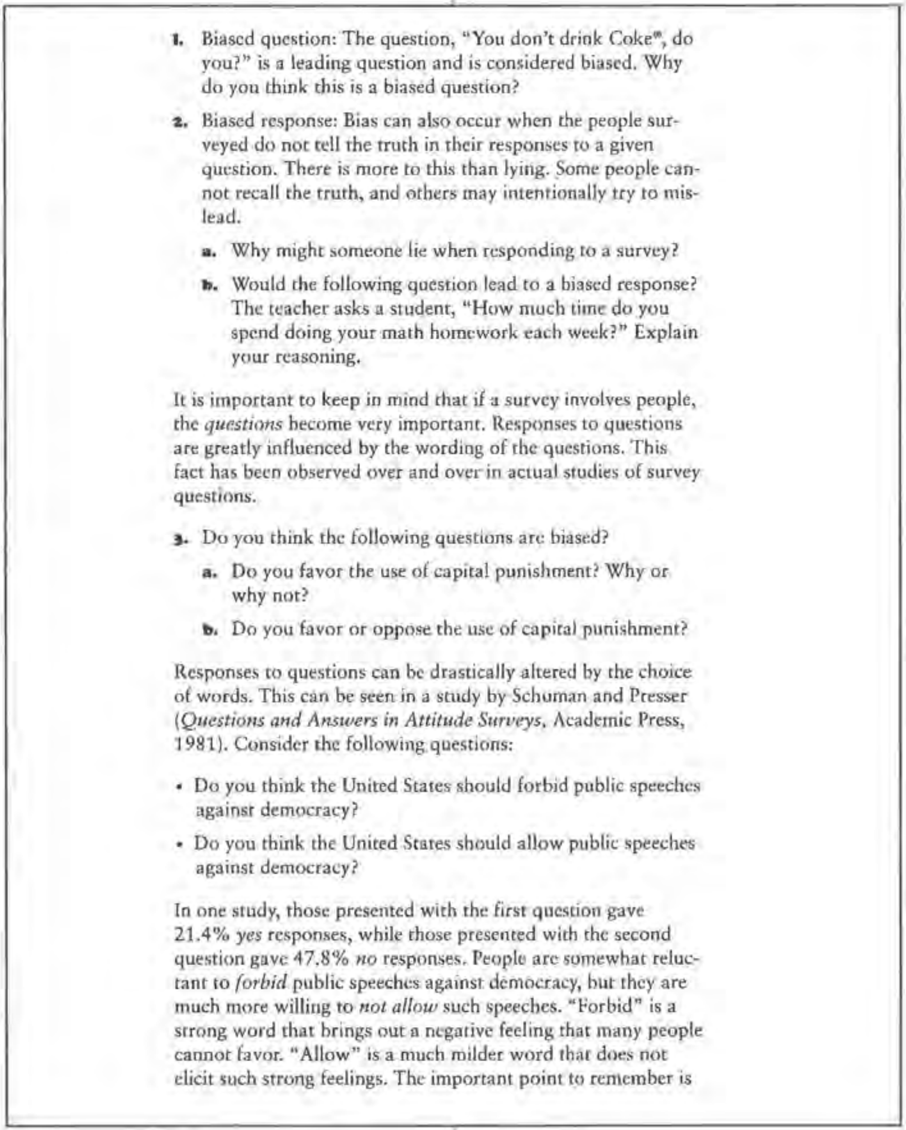
1. You are offering your opinion by asking it that way. You are "leading" people you are surveying into giving responses you desire rather than allowing them to give their own opinions.

2. **a.** The desire to please the person asking the question may be a factor. An example might be an African American asking questions about Martin Luther King Day. Fear of offending the questioner may cause the person to alter his or her response. The example in Question 1 might also apply. A person may not be willing to take the time necessary and instead give any response. Other reasons may be given by the class.

b. A student may want to please the teacher or be fearful of a response showing little time on homework.

3. The question in part b may be better than the one in part a because you have given no value judgment of your own to the question. Respondents are more free either to favor or to oppose capital punishment.

STUDENT PAGE 22



1. Biased question: The question, "You don't drink Coke®, do you?" is a leading question and is considered biased. Why do you think this is a biased question?

2. Biased response: Bias can also occur when the people surveyed do not tell the truth in their responses to a given question. There is more to this than lying. Some people cannot recall the truth, and others may intentionally try to mislead.

- **a.** Why might someone lie when responding to a survey?
- **b.** Would the following question lead to a biased response? The teacher asks a student, "How much time do you spend doing your math homework each week?" Explain your reasoning.

It is important to keep in mind that if a survey involves people, the *questions* become very important. Responses to questions are greatly influenced by the wording of the questions. This fact has been observed over and over in actual studies of survey questions.

3. Do you think the following questions are biased?

- **a.** Do you favor the use of capital punishment? Why or why not?
- **b.** Do you favor or oppose the use of capital punishment?

Responses to questions can be drastically altered by the choice of words. This can be seen in a study by Schuman and Presser (*Questions and Answers in Attitude Surveys*, Academic Press, 1981). Consider the following questions:

- Do you think the United States should forbid public speeches against democracy?
- Do you think the United States should allow public speeches against democracy?

In one study, those presented with the first question gave 21.4% *yes* responses, while those presented with the second question gave 47.8% *no* responses. People are somewhat reluctant to *forbid* public speeches against democracy, but they are much more willing to *not allow* such speeches. "Forbid" is a strong word that brings out a negative feeling that many people cannot favor. "Allow" is a much milder word that does not elicit such strong feelings. The important point to remember is

Practice and Applications

4. **a.** Students will have many examples. One example is: Do you think the mighty Green Bay Packers will win the game Sunday?

b. Who do you think will win the game Sunday, Green Bay or Pittsburgh?

c. Line plots, bar graphs, box plots, circle graphs, or stem-and-leaf plots can show the data students gathered. Students can also write a conclusion comparing the results of the two questions.

Practice

5. **a.** The presence of the officer could bias the response. The word *respect* is not clearly defined. Possible rewrite: A nonpolice officer asks, "Do you think police officers are doing a good job or could they improve in their enforcement of the laws?"

b. Annette is influencing the result. Possible rewrite: "What do you think of Bob Bellrichard?"

c. This can be a sensitive issue, and people may inflate or deflate their responses. A possible way to rewrite the question would be to have several options with a range of salaries. For example, "Do you earn under $20,000, between $20,000 and $40,000, or over $40,000?" The answers should be confidential, perhaps anonymously placed in a box.

d. This is an acceptable situation.

6. Part a is probably the best answer of the four given. The words *outlaw, prosecute,* and *freedom* are all emotionally charged words and may direct the response of the person being surveyed.

STUDENT PAGE 23

that the tone of the question set by the words employed can have a significant impact on the responses.

Practice and Applications

4. Think of a survey topic.

a. Write an intentionally biased question about your topic. Ask 30 people to respond to your biased question and record the results.

b. Write the same question in what you consider a nonbiased way. Ask 30 different people to respond to your nonbiased question and record the results.

c. Compare the results of the two versions.

5. Indicate if there is bias in the sample survey questions below. Rewrite the question to eliminate the bias if it exists.

a. The Groton Police Department would like to know if the students respect methods the police use to enforce the laws of the community. Officers in full uniform survey a sample of students in person.

b. Annette Smith, a girl at Steffen Middle School, wants to find out if any of her classmates like Bob Bellrichard. In conversation with all the girls in her class, she says, "Isn't Bob Bellrichard a creep? What do you think about him?"

c. "How much money do you earn?"

d. Nancy French had each member of her English class fill out an unsigned sample survey that posed the following question, "Do you drink alcohol?" She had their responses put in a large collection box.

6. Sam Sinclair wants to find out how people feel about political demonstrations. Select the best question or write your own. Defend your choice.

a. Should political demonstrations be allowed?

b. Should all political demonstrations be outlawed?

c. Should people who participate in political demonstrations be prosecuted?

d. Should all citizens have the freedom to express their political views through public demonstrations?

7. Answers will vary.

8. Answers will vary. Survey results are often reported in newspapers or special-interest magazines.

   Notice how the responses are obtained. Some are simply voluntary responses from those who choose to write or call. This type of bias is addressed in Lesson 5.

STUDENT PAGE 24

7. Write two sample survey questions that contain bias. Share your questions with another group. Have the members of that group rewrite them to minimize bias.

8. Find an article in a magazine that contains the actual questions in a survey. Many teen magazines such as *Seventeen* include such articles. Other magazines, such as *Time* or *Newsweek*, often contain polls. Decide if the questions are biased.

LESSON 5

Selecting a Sample

Materials: random-number tables or *Activity Sheet 2*, or ten-sided dice
Technology: graphing calculators (optional)
Pacing: 1 class period or less

Overview

To obtain representative information, the subject must be selected on a random basis. Students are familiar with using dice, spinning a spinner, or selecting numbers from a hat. They may not be familiar with using a random-number table or a random-number generator on a calculator. This lesson first shows how and why a random-number table is used. It then asks students to determine if samples taken in different situations are randomly selected.

Teaching Notes

This lesson will engender discussion about randomness. Students often believe they can be fair in their selections without using random means. They also believe "random" means by accident or without any plan. The next lesson goes into more detail about randomness.

The lengths to which pollsters such as Gallup go to make sure randomness is achieved is very interesting. You may want to have students research these methods. There is some information about this in Lesson 7. Often, there are research agencies that have offices in shopping malls. These agencies have speakers who are available to come into the classroom and speak with students.

Technology

Graphing calculators (optional) can be used to generate random numbers. On the TI-83 calculator, **MATH/PRB/rand** will give a decimal between 0 and 1. The sequence *int* (10 × *rand*) + 1 will give a random number between 1 and 10. For more information, see the calculator manual.

Solution Key

Discussion and Practice

1. Yes. The sample asked was not representative of the total population of the school.
2. No. The survey represented only one portion of the student body.
3. **a.** He is not likely to catch any big fish or those who live in very deep water. As a result, the sample is not representative of the target population.

STUDENT PAGE 25

LESSON 5

Selecting a Sample

Can just anyone be asked to participate in a survey?

How should you choose people to participate?

OBJECTIVES

Apply randomization in sample selection.

Recognize and analyze sampling bias.

Choosing a sample that does *not* represent the target population is *sampling bias*. Randomization is a statistical method that is used to minimize sampling bias.

INVESTIGATE

Sampling Bias

When a survey reflects sampling bias, its results cannot be considered valid. So it is very important to ensure against this type of bias when constructing and conducting a survey.

Discussion and Practice

Cheerleaders of one school wanted to recognize the most popular activity in the school. They decided to interview the first 25 students they met. Their survey results indicated that band was the most popular activity. The only problem was that band practice had just ended, and the 25 people they asked were all members of the band.

1. Were the methods used in this survey likely to produce a sample that was representative of all the students in the school? Why or why not?
2. Did the methods reflect sampling bias?
3. Describe the sampling bias in these examples:
    a. Frankie Rivera wants to find out what type of fish are in Lake Michigan. His method of data collection is standing on the shoreline and scooping up the fish in a net.

b. If the World Series is on television, the fans are more than likely at home watching the game. As a result, the sample is not representative of the target population.

STUDENT PAGE 26

b. Alicia Ball wants to find out what percentage of people are baseball fans. Her method of data collection is to survey people in a shopping mall during a World Series game.

There are many ways to reduce sampling bias. If you want a sample from a particular grade level, you might go to the classroom of a specific grade and ask every third person who enters. If the classes are arranged randomly by a central computer, you might be able to use an entire class as a sample of the population.

Randomization allows all elements in the population to have an equal chance of being selected. In other words, with randomization you are able to obtain a sample that is representative of the target population and to reduce sampling bias.

One of the best ways to minimize sampling bias is to use a *random-number table* as part of the process of selecting a sample. The numbers in the random-number table below have been randomly generated by a computer. Random-number tables are easy to use. A much larger Table of Random Numbers is shown at the end of this lesson on page 29.

39634	62349	73088	65564	16379	19713	39153	69459	17986	24537
14595	15050	40469	27478	44526	67331	93365	54526	22356	93208
30734	71571	83722	79712	25775	65178	07763	82928	31131	30196
64628	89126	91254	24090	25752	03091	39411	73146	06089	15630
42831	95113	43511	42082	15140	34733	68076	18292	69486	80468
80583	70361	41047	26792	78466	03395	17635	09697	82447	31405
00209	90404	99457	72570	42194	49043	24330	14939	09865	45906

How to use random numbers:

I. Drop your pencil randomly on page 29 and begin reading at the number closest to the point of the pencil.

II. Choose a direction and read the numbers in that direction. The numbers can be read up or down, or to the right or left.

III. If you want one-digit numbers from 0 to 9, use each single digit in the order that you choose.

IV. If you want two-digit numbers, group the numbers in pairs and read in whatever order you choose.

Practice and Applications

4. Students 30 and 4

5. **a.** You might go diagonally or select the first number in each group of five.

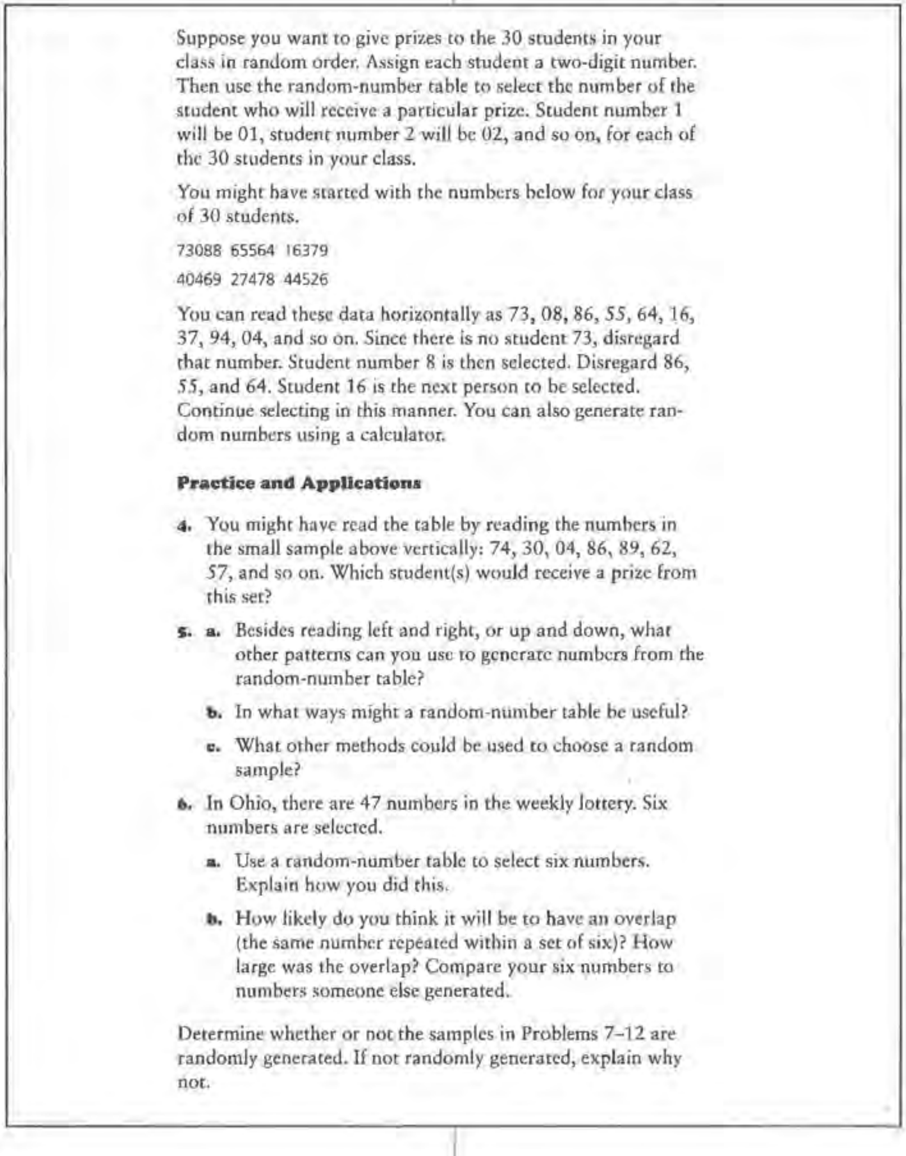
b. Any time you need a truly random sample in a situation, a random number table is helpful. One specific example might be in the selection of students to take a standardized test such as the NAEP test. Only a certain number of students is required, and the makers of the test want a truly random sample.

c. You could use the lottery method of putting balls in a bag and select from the bag. You could toss a die or spin a spinner. Students may come up with other methods.

6. **a.** Answers will vary. Be sure to look for randomness in the method of selection and for correct grammar and spelling.

b. There will certainly be some overlapping numbers, but you might point out that the likelihood all six numbers will be the same is very small.

STUDENT PAGE 27



Suppose you want to give prizes to the 30 students in your class in random order. Assign each student a two-digit number. Then use the random-number table to select the number of the student who will receive a particular prize. Student number 1 will be 01, student number 2 will be 02, and so on, for each of the 30 students in your class.

You might have started with the numbers below for your class of 30 students.

73088 65564 16379

40469 27478 44526

You can read these data horizontally as 73, 08, 86, 55, 64, 16, 37, 94, 04, and so on. Since there is no student 73, disregard that number. Student number 8 is then selected. Disregard 86, 55, and 64. Student 16 is the next person to be selected. Continue selecting in this manner. You can also generate random numbers using a calculator.

Practice and Applications

4. You might have read the table by reading the numbers in the small sample above vertically: 74, 30, 04, 86, 89, 62, 57, and so on. Which student(s) would receive a prize from this set?

5. **a.** Besides reading left and right, or up and down, what other patterns can you use to generate numbers from the random-number table?

b. In what ways might a random-number table be useful?

c. What other methods could be used to choose a random sample?

6. In Ohio, there are 47 numbers in the weekly lottery. Six numbers are selected.

a. Use a random-number table to select six numbers. Explain how you did this.

b. How likely do you think it will be to have an overlap (the same number repeated within a set of six)? How large was the overlap? Compare your six numbers to numbers someone else generated.

Determine whether or not the samples in Problems 7–12 are randomly generated. If not randomly generated, explain why not.

7. This is not a random sample. All the students in calculus class will probably go to college.

8. This is not a random sample. All of the answers will be "yes" because they are going through the line to get food prepared by the cafeteria staff.

9. This will not reach people who never go to the mall, such as housebound individuals, some elderly people, or people who do not like to shop.

10. This is not a random selection. The students most likely to be picked are in the middle of the grade book.

11. This is probably okay if the mall draws from the entire community.

12. A certain type of tree may be diseased and, therefore, an entire block may be affected. Conversely, an entire block of diseased trees may be missed. This could adversely affect the outcome of the sample survey.

13. Answers will vary. The topic should be modified to suit individual classes.

STUDENT PAGE 28

7. Nick Lilja wants to sample a portion of the senior class to find out how many will attend college next year. He asks calculus students.

8. Lakisha wants to do a survey to find out how many students eat the food prepared by the cafeteria staff. She stands at the end of the serving line and conducts her survey.

9. Marie is collecting data to find out how many people in her community recycle. She stands outside the main entrance of a town mall and asks every fifth person three questions.

10. Ms. Madonio teaches fourth grade at Oriole Lane. She needs three volunteers to help the principal, Ms. Matuk, deliver mail. Almost all of the students eagerly want to help Ms. Matuk. To select her three volunteers, Ms. Madonio pulls out her class list and without looking points to three student names.

11. Chris is designing a project to estimate the percentage of American-made vehicles in her community. She decides to count the cars at the local shopping mall on Friday evening and observe how many of them are American-made.

12. A city government needs to estimate the number of diseased trees in the city. A city crew drives down two city streets that intersect. They count diseased trees in each block. The average number of diseased trees per block can then be multiplied by the total number of blocks in the city to produce the final estimate.

13. **Extend** You wish to find out if permitting students to wear shorts should be part of your school's dress code. Have each group member explain how the collection of the data to answer this question could be randomized. Share your data-collection methods with another group.

STUDENT PAGE 29

Table of Random Numbers

59718	77768	50032	53440	41359	33021	01938	86092	87426	80010
91977	35682	34043	26290	40447	12411	32837	12151	21227	81491
88224	92826	92683	66928	95518	70106	92397	62132	97206	26324
01288	56565	78378	72344	12566	58325	40257	93212	49208	51320
19483	45024	12857	46267	94007	98674	54199	29738	24084	91964
33652	12588	55326	05702	43815	61284	13606	65461	70415	91440
32207	57357	18841	61415	57755	46846	41427	35285	37870	55929
99945	87321	41676	70537	39341	45154	93823	14053	81888	11464
29773	64388	95180	80750	12815	77661	89578	42194	99329	21247
92329	55414	05162	94197	19267	68846	27895	12005	80292	49745
75834	71767	45378	40316	61259	13140	66115	61564	76757	62599
22755	89933	41019	18996	13005	31853	72795	22193	59897	62049
09056	73260	95209	33157	15608	37565	93590	85486	80932	76059
66250	96883	74585	74550	89984	28356	77938	69704	19034	19744
37052	83115	38995	52825	93308	75276	21274	48777	75400	62004
81653	74197	85789	50614	52742	48213	94759	80701	08234	44686
41417	37426	42282	34323	83341	38345	83018	25015	68282	94820
27862	25188	15227	90981	06296	86815	04322	44750	01554	91302
85083	13673	29208	17587	12217	24032	52318	83860	81936	29114
05649	48381	63320	11822	11590	75112	54027	56579	81397	14691
91654	28637	01627	24482	33119	29924	69390	85040	66927	63521
43540	82299	18928	35588	55113	78385	61536	49596	05202	40993
33276	99974	62800	97999	56683	61505	85617	32656	16834	88980
18139	96384	07488	32049	53532	12159	75508	10924	25298	96474
07403	42795	55422	49346	44612	61632	81241	04660	95163	16285
05374	34289	66087	74636	64247	73598	42730	79472	79834	72702
63121	17926	84377	16927	91950	26475	10086	61879	03475	64750
66148	59081	34743	69023	50306	63739	14717	32374	19119	96284
92153	23320	34180	78025	42391	35908	73996	49173	47360	92856
06629	93991	80847	49133	45105	34818	10122	31369	33312	94856
74784	07080	13104	64110	98440	56468	88959	67988	58764	70414
59043	74797	24791	65130	97918	99820	32673	44512	36847	14028
58572	79127	74870	47218	03752	92434	71791	28040	60536	37429
75069	76687	43795	50161	20794	95015	42376	33178	10265	03394
72258	09820	54814	84454	32761	59316	14974	80017	37524	25760
16186	64983	27652	53966	75826	16790	13767	52267	65505	56954
54047	17961	92967	27968	12463	85270	13763	96297	43279	93087
42301	36874	19357	14982	22806	69213	79929	48973	21969	78172
87940	43389	26009	52702	03148	70789	88539	19084	59200	88168
91551	24267	81423	17461	09300	11928	98793	97748	95430	11644
03166	69589	65596	56997	70092	63418	92825	91586	76847	51167
64280	45356	96248	79274	15733	72317	44107	80124	99627	44523
28464	37825	88800	20180	28989	75914	46882	28736	60408	63180
36861	76806	80789	30886	71013	56044	52405	81063	04283	41256
43125	34876	18177	22382	37920	77067	93319	29881	37050	32533

LESSON 6

Studying Randomization

Materials: random-number tables or *Activity Sheets 2* and *3*, rulers or straightedges
Technology: computer and graphing program
Pacing: 2 class periods or less, depending upon abilities of students

Overview

This lesson gives evidence that randomization is important when selecting a sample.

Teaching Notes

The 100 Random Rectangles (Student page 32) have been reproduced for convenience on *Activity Sheet 3*. Also the Table of Random Numbers appears on *Activity Sheet 2*. When covering this lesson with younger students, you will find that

- while they know what a random number is, unless they have worked through the earlier lessons, they have no concept of selecting a random sample. You must be very clear from the beginning what they will be doing.
- even though they know what area is and if given five areas they can find the average, some students will make very poor estimates for the rectangles' areas. Some students guess in the hundreds because they think of the total areas rather than the average. It is important to remind these students that the average area must be between the least and greatest areas.

The unit of measure is the smallest square. Thus, rectangle number 33 has an area of 4 × 3, or 12, square units. The actual average area of the rectangles is 7.39 square units. The true standard deviation is 5.19. For more information on standard deviation, see the module entitled *Exploring Symbols: An Introduction to Expressions and Functions*.

Encourage older students to arbitrarily select rectangles for the judgmental sample. Some will try to be scientific, and the results will distort the comparison.

Solution Key

Discussion and Practice

1. The following is a set of data collected from the eighth graders at Brown Middle School in Ravenna, Ohio.

a. Guess: 12, 9, 13, 12, 9, 10, 7, 12, 13, 11, 11, 10, 22, 7, 7, 12, 7, 7, 16, 18, 15, 9, 8, 14, 18, 17

Mean = 11.8

b. Judgmental Sample: 9, 11.2, 10.6, 8.7, 10.2, 9.5, 9.8, 12.2, 6.7, 8.5, 10, 8.6, 11, 9, 3.3, 10, 9.3, 9, 12, 17.4, 15.8, 8.5, 9.3, 13.6, 17.4, 7.3

Mean = 10.3

STUDENT PAGE 30

LESSON 6

Studying Randomization

Why do newspapers and magazines often emphasize that samples used in polls (sample surveys) have been randomly selected?

Could an intelligent person do better than a random sample by carefully choosing respondents to represent various groups?

OBJECTIVE

Recognize that randomization reduces sampling bias.

INVESTIGATE

The Importance of Randomization

The following activity deals with the average area of 100 rectangles. This lesson will emphasize why randomization is important in a sample selection.

Discussion and Practice

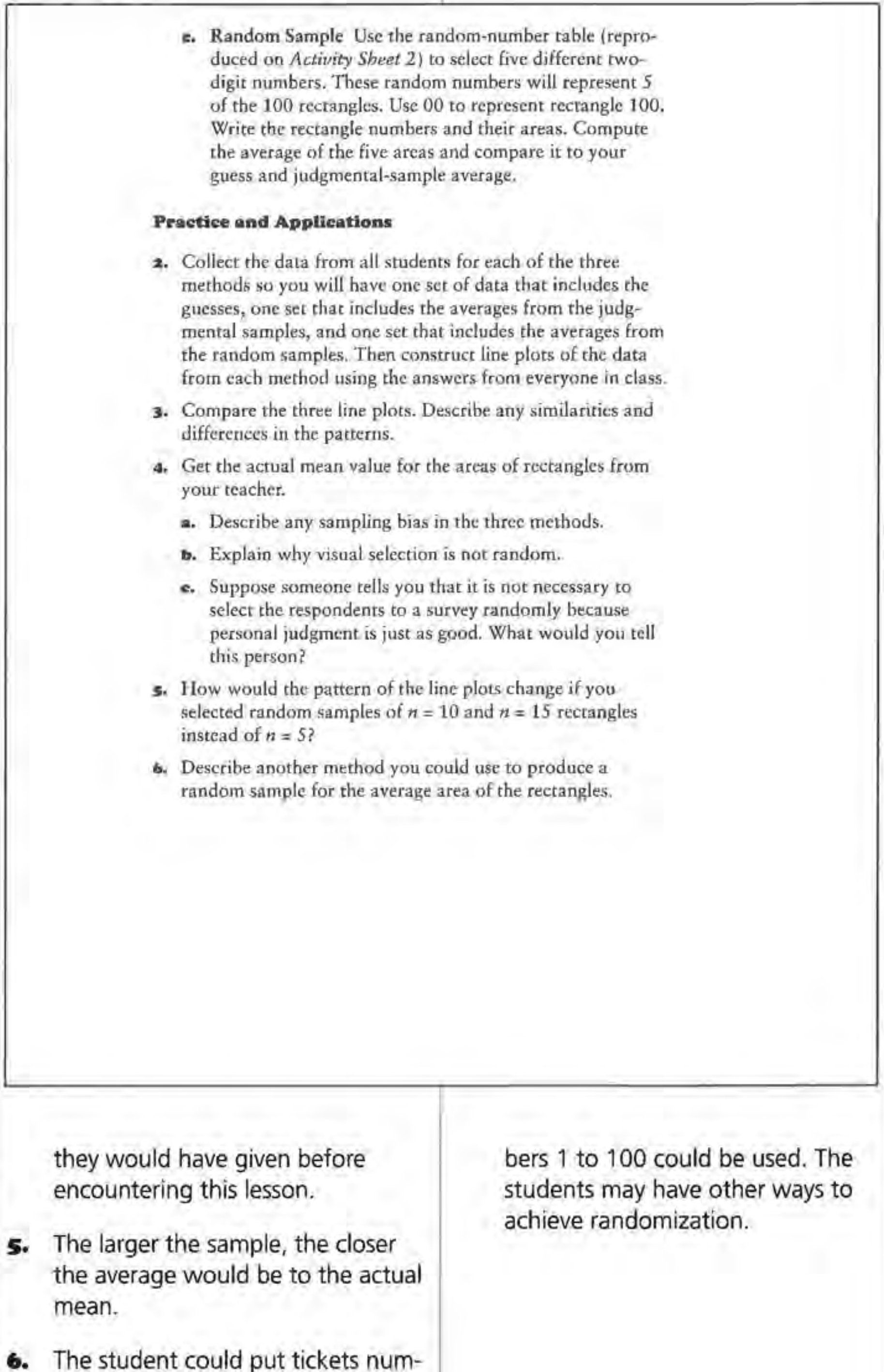
Suppose you want to estimate the average area of 100 rectangles. How can you do this without calculating the area of each rectangle?

1. Estimate the average area for all the rectangles pictured on page 32. Use each of the methods listed below. Note that rectangle 45 has area of 2 × 5 = 10 square units.

a. Guess Write your guess for the average area of the rectangles on the sheet.

b. Judgmental Sample Select five rectangles you think are representative of the rectangles on the page. Write the rectangle numbers and their areas. Compute the average of the five areas and compare it to the average you guessed.

STUDENT PAGE 31



c. **Random Sample** Use the random-number table (reproduced on *Activity Sheet 2*) to select five different two-digit numbers. These random numbers will represent 5 of the 100 rectangles. Use 00 to represent rectangle 100. Write the rectangle numbers and their areas. Compute the average of the five areas and compare it to your guess and judgmental-sample average.

Practice and Applications

2. Collect the data from all students for each of the three methods so you will have one set of data that includes the guesses, one set that includes the averages from the judgmental samples, and one set that includes the averages from the random samples. Then construct line plots of the data from each method using the answers from everyone in class.

3. Compare the three line plots. Describe any similarities and differences in the patterns.

4. Get the actual mean value for the areas of rectangles from your teacher.

a. Describe any sampling bias in the three methods.

b. Explain why visual selection is not random.

c. Suppose someone tells you that it is not necessary to select the respondents to a survey randomly because personal judgment is just as good. What would you tell this person?

5. How would the pattern of the line plots change if you selected random samples of $n = 10$ and $n = 15$ rectangles instead of $n = 5$?

6. Describe another method you could use to produce a random sample for the average area of the rectangles.

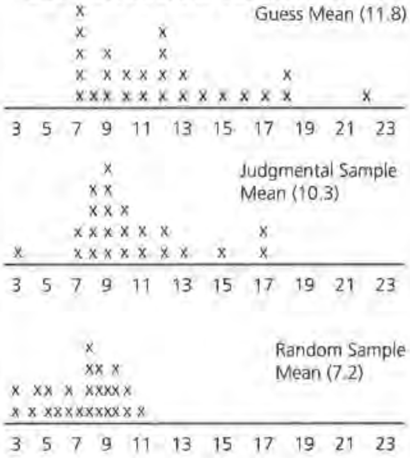
c. Random Sample: 8.2, 4.5, 11.1, 5, 9.3, 9.5, 7.8, 9.5, 8, 5.3, 6.2, 9.2, 8.2, 7.7, 8.5, 7.5, 8.7, 6.7, 9, 4, 7.3, 6.7, 2, 5.5, 9, 2.8

Mean = 7.2

Practice and Applications

2.

Line Plots of Three Sample Methods



3. You will want students to note that while there is variability in all three samples, it certainly lessens in the random sample compared to the other two samples. It is also important to note that the mean of the random sample will probably be much closer to the actual population (the mean of all of the rectangles on the page).

4. **a.** It is good here to have students explain how they got their guesses and their judgmental samples. Some take the smallest and the largest and find the average of those. There are a variety of other techniques students use in making their guesses and picking the rectangles for their samples.

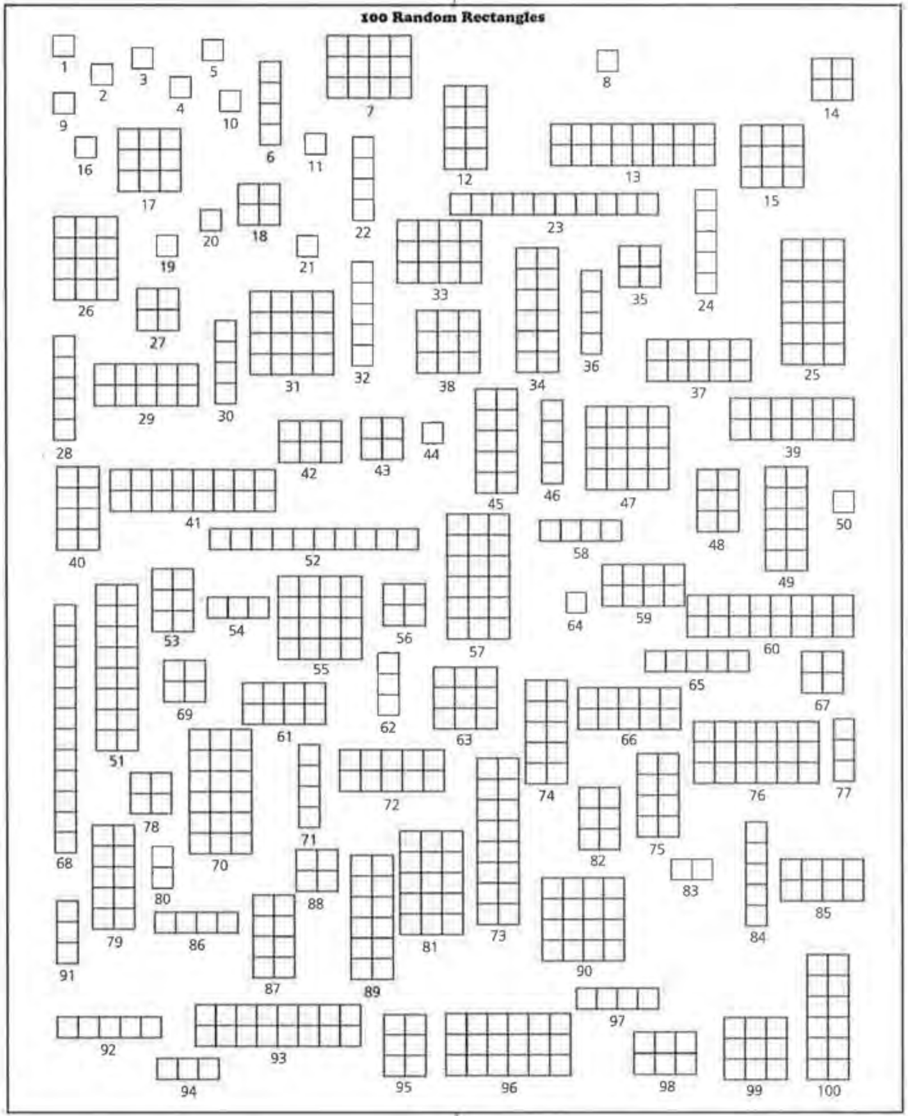
b. Just as in part a above, visual selection involves the bias of the selector.

c. The answers students give should be very different from those they would have given before encountering this lesson.

5. The larger the sample, the closer the average would be to the actual mean.

6. The student could put tickets numbered 1 to 100 in a bag and select one ticket at a time until five are selected. The ticket would need to be replaced each time so you were always selecting from 100 rectangles. Or a spinner with the numbers 1 to 100 could be used. The students may have other ways to achieve randomization.

STUDENT PAGE 32



100 Random Rectangles

LESSON 7

Sampling in the Real World

Materials: none
Technology: none
Pacing: 1 class period

Overview

This lesson should help students understand the descriptions of surveys they encounter in magazines and newspapers and on television.

Teaching Notes

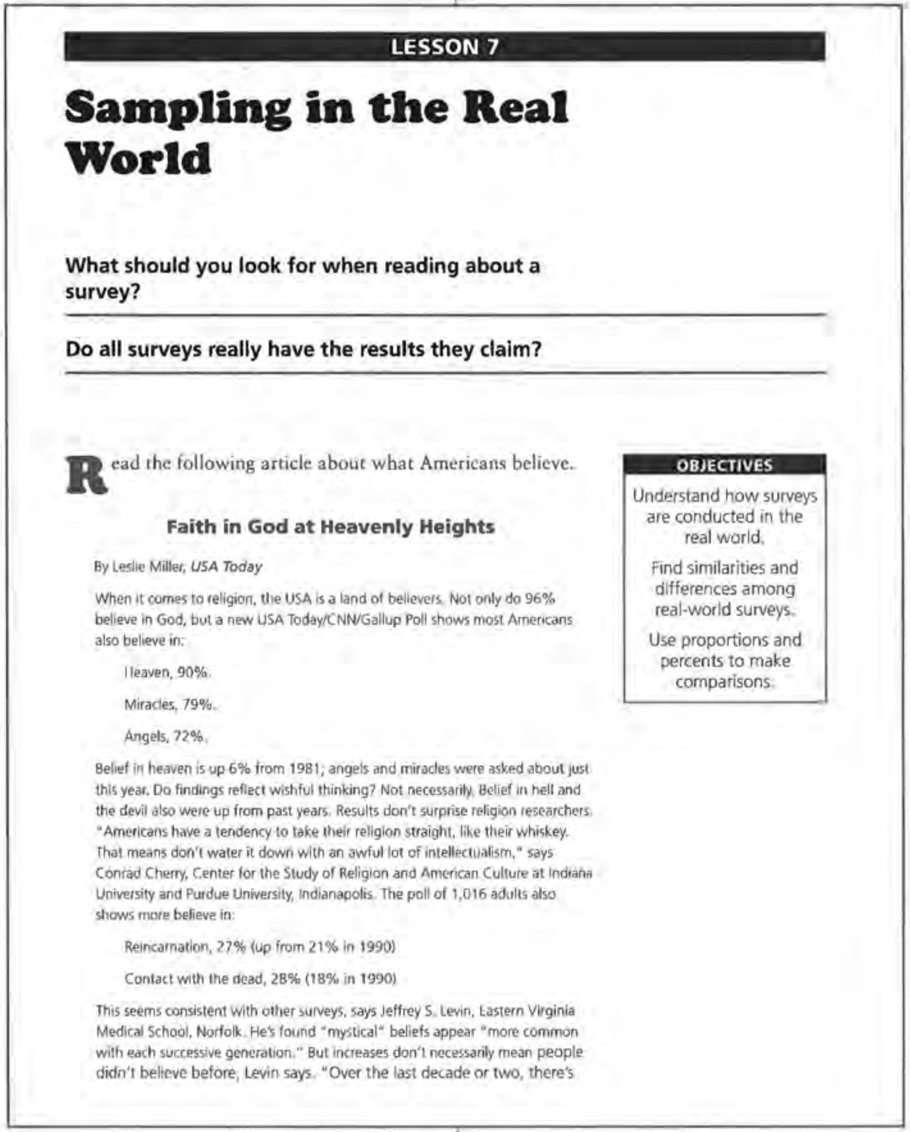
Students should be encouraged to read critically. Gallup and A.C. Nielsen Co. are examples of professional polling organizations. A.C. Nielsen does most of the polling for television ratings. Businesses often conduct polls or hire professional organizations to do so.

Some things to consider before assigning the problems in this lesson are:

- Younger students may need help analyzing the articles.
- The introductory article, the article about the Gallup polls, and the article about Nielsen ratings deal with national surveys. You may want to discuss how the articles compare before students read the selection.
- To facilitate students' analyzing of the articles, have them work in small groups to compare and contrast their findings.

This lesson can be done by having students describe the articles, then follow with a discussion. This would probably take one class period. It could be done in much more depth by using small groups, describing the surveys, and having students write their results to the Practice questions.

STUDENT PAGE 33



LESSON 7

Sampling in the Real World

What should you look for when reading about a survey?

Do all surveys really have the results they claim?

OBJECTIVES

Understand how surveys are conducted in the real world.

Find similarities and differences among real-world surveys.

Use proportions and percents to make comparisons.

Read the following article about what Americans believe.

Faith in God at Heavenly Heights

By Leslie Miller, *USA Today*

When it comes to religion, the USA is a land of believers. Not only do 96% believe in God, but a new USA Today/CNN/Gallup Poll shows most Americans also believe in:

Heaven, 90%.

Miracles, 79%.

Angels, 72%.

Belief in heaven is up 6% from 1981; angels and miracles were asked about just this year. Do findings reflect wishful thinking? Not necessarily. Belief in hell and the devil also were up from past years. Results don't surprise religion researchers. "Americans have a tendency to take their religion straight, like their whiskey. That means don't water it down with an awful lot of intellectualism," says Conrad Cherry, Center for the Study of Religion and American Culture at Indiana University and Purdue University, Indianapolis. The poll of 1,016 adults also shows more believe in:

Reincarnation, 27% (up from 21% in 1990)

Contact with the dead, 28% (18% in 1990)

This seems consistent with other surveys, says Jeffrey S. Levin, Eastern Virginia Medical School, Norfolk. He's found "mystical" beliefs appear "more common with each successive generation." But increases don't necessarily mean people didn't believe before, Levin says. "Over the last decade or two, there's

Solution Key

Discussion and Practice

1. Gallup polled 1,016 adults in 1994.

2. The exact questions are not given in the article, but the responses indicate that they asked if Americans believed in heaven, miracles, angels, hell, the devil, reincarnation, and contact with the dead.

3. Since this is a poll about what Americans believe, most people would be interested. Most would compare their own beliefs with those stated in the poll.

4. Sample answers are given.

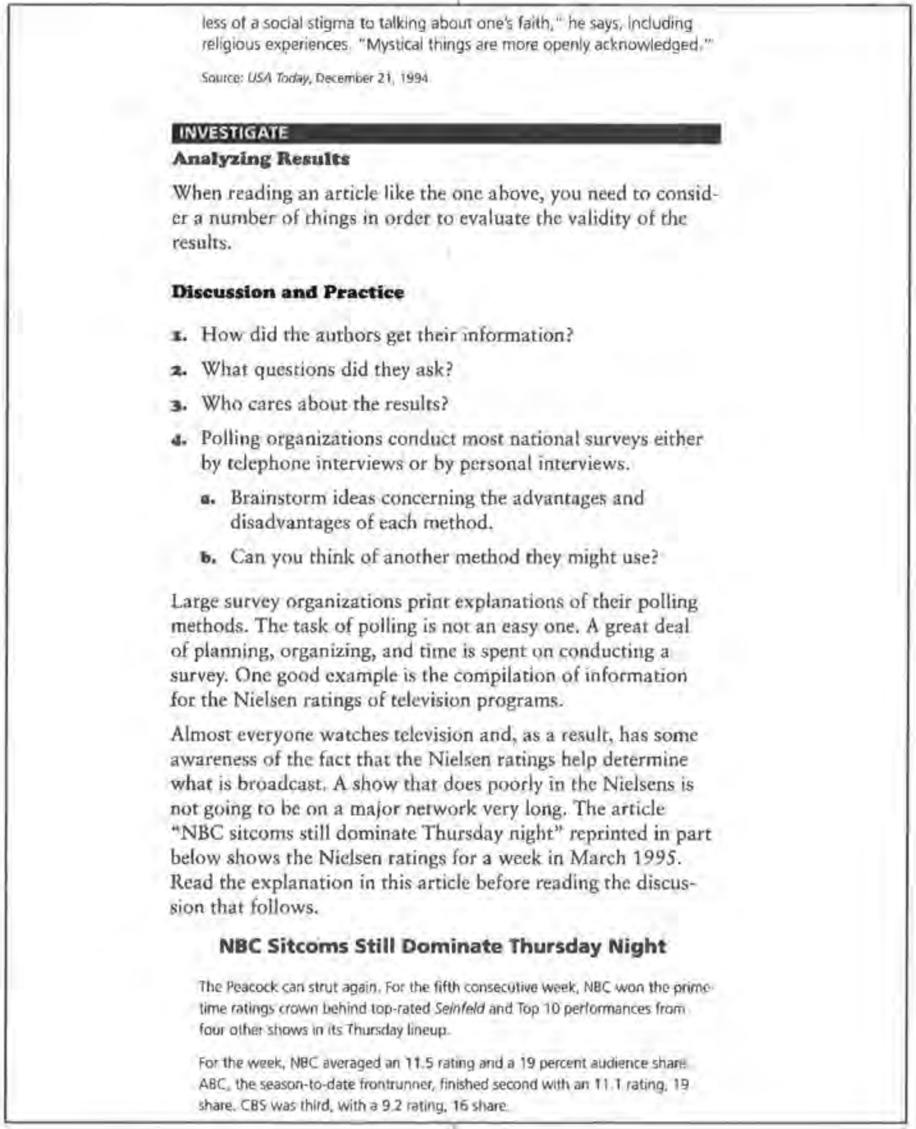
a.

Advantages of Telephone Surveys	Disadvantages of Telephone Surveys
Easy to randomize	Not everyone has a phone
Cost-effective	No personal contact
Quicker	Often annoying to people
Very standardized	

Advantages of Personal Interviews	Disadvantages of Personal Interviews
May be more accurate	Higher cost
People not at home	

b. Mailing questionnaires might be another method.

STUDENT PAGE 34



less of a social stigma to talking about one's faith," he says, including religious experiences. "Mystical things are more openly acknowledged."

Source: *USA Today*, December 21, 1994

INVESTIGATE

Analyzing Results

When reading an article like the one above, you need to consider a number of things in order to evaluate the validity of the results.

Discussion and Practice

1. How did the authors get their information?

2. What questions did they ask?

3. Who cares about the results?

4. Polling organizations conduct most national surveys either by telephone interviews or by personal interviews.

  a. Brainstorm ideas concerning the advantages and disadvantages of each method.

  b. Can you think of another method they might use?

Large survey organizations print explanations of their polling methods. The task of polling is not an easy one. A great deal of planning, organizing, and time is spent on conducting a survey. One good example is the compilation of information for the Nielsen ratings of television programs.

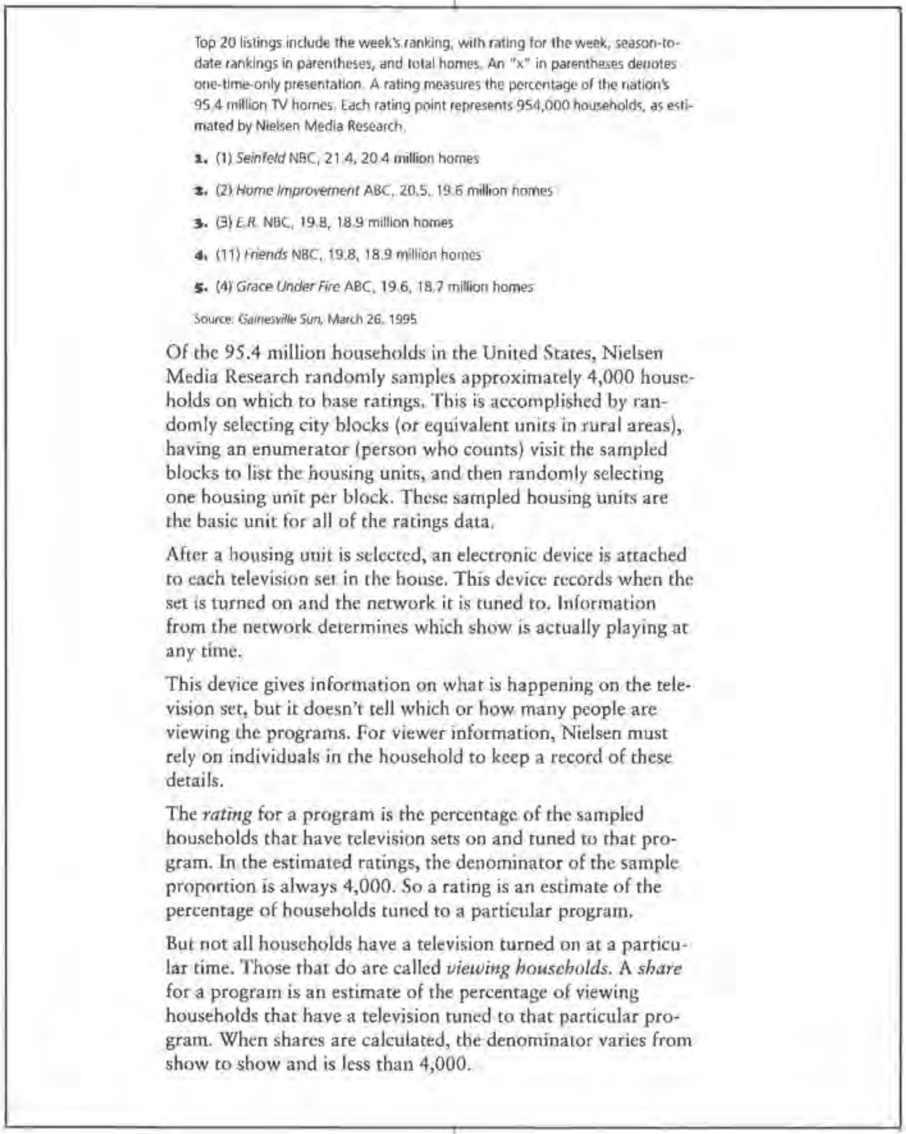
Almost everyone watches television and, as a result, has some awareness of the fact that the Nielsen ratings help determine what is broadcast. A show that does poorly in the Nielsens is not going to be on a major network very long. The article "NBC sitcoms still dominate Thursday night" reprinted in part below shows the Nielsen ratings for a week in March 1995. Read the explanation in this article before reading the discussion that follows.

NBC Sitcoms Still Dominate Thursday Night

The Peacock can strut again. For the fifth consecutive week, NBC won the prime-time ratings crown behind top-rated *Seinfeld* and Top 10 performances from four other shows in its Thursday lineup.

For the week, NBC averaged an 11.5 rating and a 19 percent audience share. ABC, the season-to-date frontrunner, finished second with an 11.1 rating, 19 share. CBS was third, with a 9.2 rating, 16 share.

STUDENT PAGE 35



Top 20 listings include the week's ranking, with rating for the week, season-to-date rankings in parentheses, and total homes. An "x" in parentheses denotes one-time-only presentation. A rating measures the percentage of the nation's 95.4 million TV homes. Each rating point represents 954,000 households, as estimated by Nielsen Media Research.

1. (1) *Seinfeld* NBC, 21.4, 20.4 million homes
2. (2) *Home Improvement* ABC, 20.5, 19.6 million homes
3. (3) *E.R.* NBC, 19.8, 18.9 million homes
4. (11) *Friends* NBC, 19.8, 18.9 million homes
5. (4) *Grace Under Fire* ABC, 19.6, 18.7 million homes

Source: *Gainesville Sun*, March 26, 1995

Of the 95.4 million households in the United States, Nielsen Media Research randomly samples approximately 4,000 households on which to base ratings. This is accomplished by randomly selecting city blocks (or equivalent units in rural areas), having an enumerator (person who counts) visit the sampled blocks to list the housing units, and then randomly selecting one housing unit per block. These sampled housing units are the basic unit for all of the ratings data.

After a housing unit is selected, an electronic device is attached to each television set in the house. This device records when the set is turned on and the network it is tuned to. Information from the network determines which show is actually playing at any time.

This device gives information on what is happening on the television set, but it doesn't tell which or how many people are viewing the programs. For viewer information, Nielsen must rely on individuals in the household to keep a record of these details.

The *rating* for a program is the percentage of the sampled households that have television sets on and tuned to that program. In the estimated ratings, the denominator of the sample proportion is always 4,000. So a rating is an estimate of the percentage of households tuned to a particular program.

But not all households have a television turned on at a particular time. Those that do are called *viewing households.* A *share* for a program is an estimate of the percentage of viewing households that have a television tuned to that particular program. When shares are calculated, the denominator varies from show to show and is less than 4,000.

STUDENT PAGE 36

In reality, the ratings and shares are slightly more complicated. A rating for any program is taken minute by minute and then averaged over the length of the program. This average attempts to adjust for the fact that not all viewers watch all of a program. Thus, the final rating for *60 Minutes* would be the average of all ratings taken over the hour duration of the show. The final rating for a basketball game would be the average ratings taken over the entire time—perhaps several hours—the game was on the air.

Review the Nielsen article once again. Discuss any points that are misleading or unclear, specifically the following:

5. Why are the shares always greater than the ratings?

6. Are there sources of potential bias in the data collection plan?

Practice and Applications

Two articles that tell about the processes used by local and national surveys are on pages 37–39.

7. To understand and appreciate the survey process better, your group will be responsible for reading one of the following articles, answering the questions, and reporting to the class. The report should include answers to the following:

- **a.** Which poll did your group investigate?
- **b.** How was the poll or survey conducted?
- **c.** What sample size did the poll use?
- **d.** What *sampling error* did your poll report? Sampling error means the amount by which the survey may differ from the actual population.
- **e.** When a person being surveyed did not respond, what happened?
- **f.** Assuming that 250 million adults live in the United States, what is the probability that a person would have been interviewed in the poll?
- **g.** Select someone from your group to report your findings.

8. After listening to the reports, answer each question.

- **a.** How are the surveys alike?
- **b.** How are the surveys different?

5. In the shares, only "viewing households" are counted. This means the denominator will differ from show to show and will be less than or equal to the total number of possible viewers. In the rating, the denominator is always the total number of possible viewers. The share will, therefore, be higher.

6. Individuals in households may be lax about keeping records on who is viewing. People may turn on the television and leave the room, then report what they would have watched but really did not. However, generally it seems to be an effective method.

Practice and Applications

7. Possible responses if referring to the Gallop Poll articles:

a. Gallup Poll

b. The United States is divided into eight geographical regions. These are divided into zones, and the zones are divided into localities. A few localities are randomly sampled from each zone. Clusters of blocks are sampled from each urban locality. Segments of the same size are sampled from urban areas. A randomly selected starting point is set. A travel path is mapped out. Interviewers continue on path until a set number of interviews with male and female respondents has been completed.

c. There is a minimum of 1,000 to 1,500 respondents.

d. A plus or minus 4% tolerance is standard.

e. Allowance is made for persons not at home by a "times-at-home" weighting procedure rather than a return visit. This reduces sample bias that would result from under representation of persons who are seldom at home.

f. $\frac{1,500}{250,000,000} = 0.000006$ is the probability an adult would be surveyed.

g. A student will report on this survey.

Possible responses if referring to TAPS:

a. The Teenage Attitudes and Practices Survey (TAPS)

b. The survey contacted a random selection of households from across the country and interviewed all teenagers between 12 and 18 years of age living in those households. The design for selecting the households was more complex than a simple random sampling, in order to guarantee that all areas of the country were covered.

c. The survey reached 9,135 teenagers through telephone interviews and another 830 through mailed questionnaires.

(7) d. The sampling error is not reported, since the exact calculation methods are complex. It does say that the sampling errors would be greater than those for simple random sampling—approximately $\frac{1}{\sqrt{9,965}} \approx 0.01$.

e. There was a low nonresponse from the telephone survey. There is no mention of follow-up to the nonresponse from the mail survey.

f. To answer this question, you need to know the number of teenagers in the U.S. That number was about 23.5 million in 1989. Thus, a rough approximation of the chance that any one teenager would have been interviewed is $\frac{1}{23,500,000} \approx 0.00000004$.

g. A student will report on this survey.

8. Possible answers are given.

- The scope of the survey can be international, national, or local.
- The sample size of the survey can be large or small.
- The way the survey is randomized in different ways.
- The survey can be a census or a sample survey.
- The survey can be conducted by telephone, in person, or by mail.

STUDENT PAGE 37

Articles About Gallup Poll Surveys

The Sample

Although most Gallup Poll findings are based on telephone interviews, a significant proportion is based on interviews conducted in person in the home. The majority of the findings reported in Gallup Poll surveys is based on samples consisting of a minimum of 1,000 interviews. The total number, however, may exceed 1,000, or even 1,500 interviews, where the survey specifications call for reporting the responses of low-incidence population groups such as young public-school parents or Hispanics.

Design of the Sample for Telephone Surveys

The findings from the telephone surveys are based on Gallup's standard national telephone samples, consisting of unclustered directory-assisted, random-digit telephone samples. The random-digit aspect of the sample is used to avoid "listing" bias. Numerous studies have shown that households with unlisted telephone numbers are different from listed households. "Unlistedness" is due to household mobility or to customer requests to prevent publication of the telephone number. To avoid this source of bias, a random-digit procedure designed to provide representation of both listed and unlisted (including not-yet-listed) numbers is used.

Telephone numbers for continental United States are organized into four regions of the country, and, within each region, further arranged into three strata based on the size of the community. The sample of telephone numbers produced by the described method is representative of all telephone households within the continental United States.

Within each contacted household, an interview is sought with the youngest man 18 years of age or older who is at home. If no man is home, an interview is sought with the oldest woman at home. This method of respondent selection within households produces an age distribution by sex that closely approximates the age distribution by sex of the total population.

Up to three calls are made to each selected telephone number to complete an interview. The time of day and the day of the week for callbacks are varied to maximize the chances of finding a respondent at home. All interviews are conducted on weekends or weekday evenings in order to contact potential respondents among the working population.

Design of the Sample for Personal Surveys

The design of a sample for personal (face-to-face) surveys is that of a probability sample down to the block level in the case of urban areas and to segments of townships in the case of rural areas.

After stratifying the nation geographically and by size of community according to information derived from the most recent census, over 350 different sampling locations are selected on a mathematically random basis from within cities, towns, and counties that, in turn, have been selected on a mathematically random basis.

STUDENT PAGE 38

The interviewers are given no leeway in selecting the areas in which they are to conduct their interviews. Each interviewer is given a map on which a specific starting point is marked and is instructed to contact households according to a predetermined travel pattern. At each occupied dwelling unit, the interviewer selects respondents by following a systematic procedure that is repeated until the assigned number of interviews has been completed.

Sampling Tolerances

Readers are cautioned that all sample surveys are subject to the potential effects of sampling error, a divergence between the survey results based on a selected sample and the results that would be obtained by interviewing the entire population in the same way. The risk of this kind of divergence is necessary if probability sampling is used, and probability sampling is the basis for confidence in the representativeness of sample survey results.

The chance that sampling error will affect a percentage based on survey results is mainly dependent upon the number of interviews on which the percentage is based. In 95 out of 100 cases, results based on national samples of 1,000 interviews can be expected to vary by no more than 4 percentage points (plus or minus the figure obtained) from the results that would be obtained if all qualified adults were interviewed in the same way. For results based on smaller national samples or on sub-samples (such as men or persons over the age of fifty), the chance of sampling error is greater and therefore larger margins of sampling error are necessary in order to be equally confident of our survey conclusions.

In addition to sampling error, readers should bear in mind that question wording, and practical difficulties encountered in conducting surveys, can introduce additional systematic error or "bias" into the results of opinion polls. Unlike sampling error, it is not possible to estimate the risk of this kind of error in a direct way, but survey organizations can protect against the effects of bias on survey conclusions by focusing careful attention on sampling, questionnaire construction, and data collection procedures and by allowing adequate time for the completion of data collection.

Source: *The Gallup Poll Monthly*, October 1993

The Teenage Attitudes and Practices Survey (TAPS)

The TAPS was a targeted population study of U.S. teenagers 12–18 years of age. The study was conducted by the National Center for Health Statistics' National Health Interview Survey (NHIS) and cosponsored by the Centers for Disease Control Office on Smoking and Health (OSH) and the National Cancer Institute (NCI).

The TAPS was designed to obtain national household data about current cigarette-smoking behavior and lifetime smoking practices of adolescents and their beliefs about smoking. Selected correlates of smoking uptake were also addressed in the study.

The TAPS sample was derived from NHIS's household interviews conducted during the final two quarters of 1988 and the first two quarters of 1989. All

STUDENT PAGE 39

teenagers living in households contacted and interviewed during this period who were 12–18 years of age as of November 1, 1989, were included in the sample. The eligible sample for the TAPS was 12,097 persons.

The TAPS utilized two modes of data collection. The primary method consisted of computer-assisted telephone interviewing (CATI) in households where a telephone number was provided during the original NHIS interview. In addition, self-administered questionnaires were mailed to sample teenagers living in households without telephones or an available telephone number. Mail questionnaires were also sent to those teenagers living in households with an original telephone number but who were never reached using the CATI method. Telephone interviews and all other data collection activities were performed by U.S. Bureau of the Census personnel. Data collection began in August 1989 and, except for late receipt of some mail questionnaires, concluded in December 1989.

Unlike the original NHIS interview, all teenagers responded for themselves. However, prior to the initial telephone contact, advance letters were mailed to a responsible related adult and to each eligible teenager in the household explaining the sponsorship and objectives of the upcoming survey and assuring confidentiality.

The total interviewed TAPS sample included 9,965 adolescents, 9,135 from CATI interviews and the remaining 830 cases from completed mail questionnaires. The total combined response rate for the TAPS from these 2 data-collection procedures was 82 percent. Most of the nonresponse resulted from teenagers' failure to return the mail questionnaire. Only 3.7 percent of interviews of adolescents reached by telephone ended in a refusal either because of the parent's or teenager's initial refusal and subsequent termination of the interview. Item nonresponse was less than 1 percent for the questions discussed in this report.

Because estimates shown in this report are based on a sample of the population rather than on the entire population, they are subject to sampling error. When an estimate of the numerator or denominator of a percent is small, the sampling error may be relatively high. In addition, the complex sample design of the NHIS has the effect of making the sampling errors larger than they would be had a simple random sample of equal size been used.

Source: U.S. Department of Health and Human Services Center for Disease Control and Prevention, 1993

LESSON 8

Critiquing a Printed Article

Materials: none
Technology: none
Pacing: 1 class period

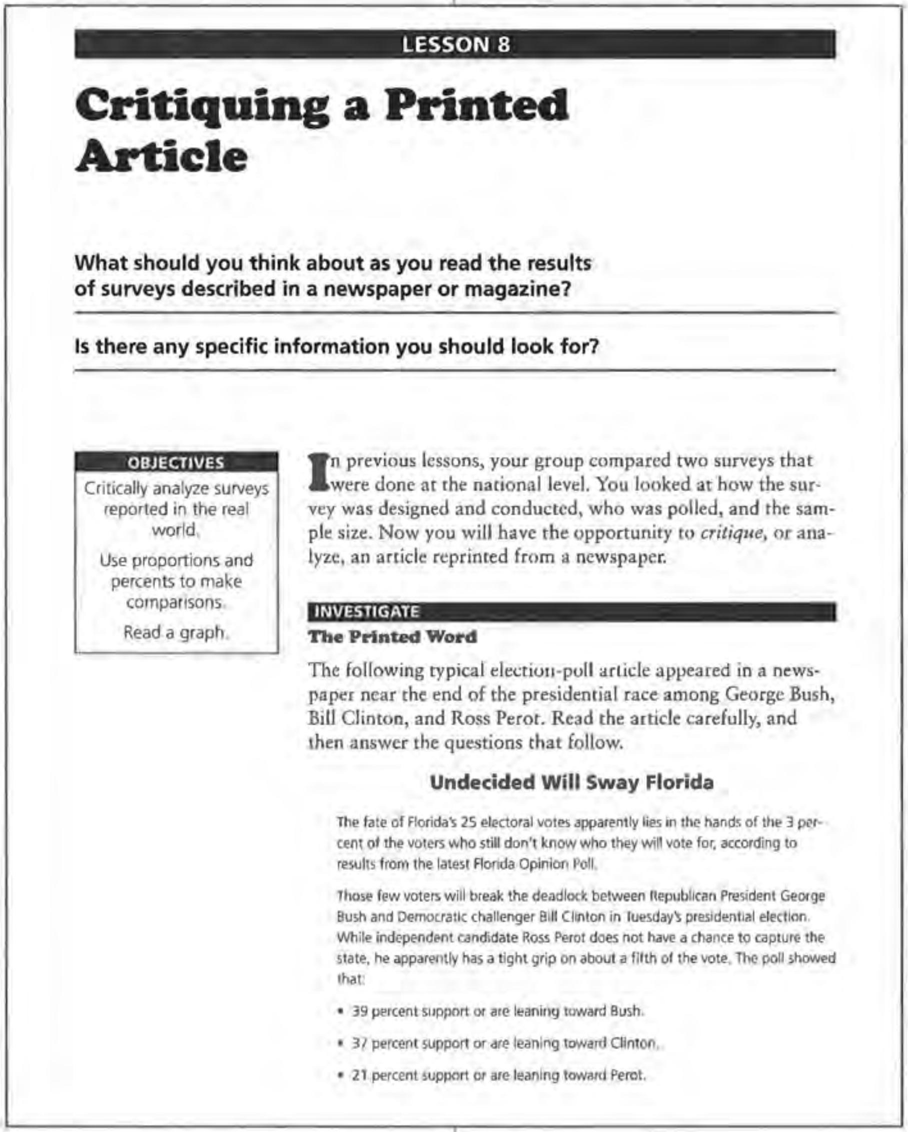
Overview

This lesson will lead students to critically analyze an article that contains survey material. Students should read the report of any survey in light of questions such as these: Who gave the survey? What questions were asked? How was the survey administered? When was the survey given? What were the results?

Teaching Notes

Students often believe that if something is in print, it is true. Students need to read critically. This lesson gives students some guidelines to use to look at an article and read it carefully. The sample article includes text and a graph to illustrate the results. It may be helpful to group the students to answer the questions, and then discuss the answers as a class. Check recent newspapers for polls or surveys to share with the class. Discussion might focus on issues such as why the survey is useful, whether the headline matches the results, or if a graph would enhance the article.

STUDENT PAGE 40



LESSON 8

Critiquing a Printed Article

What should you think about as you read the results of surveys described in a newspaper or magazine?

Is there any specific information you should look for?

OBJECTIVES

Critically analyze surveys reported in the real world.

Use proportions and percents to make comparisons.

Read a graph.

In previous lessons, your group compared two surveys that were done at the national level. You looked at how the survey was designed and conducted, who was polled, and the sample size. Now you will have the opportunity to *critique,* or analyze, an article reprinted from a newspaper.

INVESTIGATE

The Printed Word

The following typical election-poll article appeared in a newspaper near the end of the presidential race among George Bush, Bill Clinton, and Ross Perot. Read the article carefully, and then answer the questions that follow.

Undecided Will Sway Florida

The fate of Florida's 25 electoral votes apparently lies in the hands of the 3 percent of the voters who still don't know who they will vote for, according to results from the latest Florida Opinion Poll.

Those few voters will break the deadlock between Republican President George Bush and Democratic challenger Bill Clinton in Tuesday's presidential election. While independent candidate Ross Perot does not have a chance to capture the state, he apparently has a tight grip on about a fifth of the vote. The poll showed that:

- 39 percent support or are leaning toward Bush.
- 37 percent support or are leaning toward Clinton.
- 21 percent support or are leaning toward Perot.

STUDENT PAGE 41

- 3 percent are undecided.

The Florida Opinion Poll, which is sponsored by the New York Times newspapers in Florida, contacted state residents in a random telephone sample. Along the political spectrum, Bush is heavily dependent on conservatives in Florida, while Clinton captures nearly half the moderate voters and nearly three quarters of the liberals. Perot pulls almost identical support from liberals and conservatives, while drawing a quarter of moderates.

The poll found that among conservative voters:

- 63 percent back Bush.
- 18 percent back Clinton.
- 19 percent back Perot.

Among moderate voters:

- 28 percent back Bush.
- 46 percent back Clinton.
- 26 percent back Perot.

Among liberal voters:

- 11 percent back Bush.
- 71 percent back Clinton.
- 18 percent back Perot.

While Perot pulls support from across the political spectrum, he is taking away more of Bush's Republicans than Clinton's Democrats.

Among Republicans:

- 64 percent back Bush.
- 12 percent back Clinton.
- 22 percent back Perot.
- 2 percent were undecided.

But Perot takes Democratic votes from Clinton, but not as many, and there are more registered Democrats in Florida than Republicans.

Among Democrats:

- 20 percent back Bush.
- 61 Percent back Clinton.
- 17 percent back Perot.
- 2 percent were undecided.

Of the 6.5 million registered voters in Florida, 3.3 million, or 51 percent, are registered as Democrats, while 2.7 million voters, or 41 percent, are registered as Republicans and 550,292 or 8 percent are registered as Independents or members of third parties.

STUDENT PAGE 42

By age, candidates seem to appeal equally across all age groups, with each drawing in the 30 percent range, except for the 45–64 year-olds.

By gender, there appears to be no major difference in the number of women or men going for one candidate more than the others.

Source: *The Gainsville Sun*, October 30, 1992

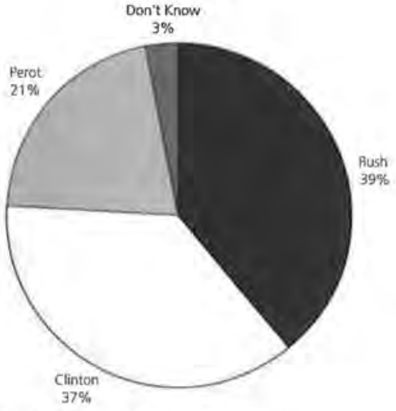
How the Polls Were Conducted

The latest Florida Opinion Poll was conducted by telephone from Oct. 24 to 27 with 773 voters considered most likely to go to the polls on Election Day. The telephone numbers used in the survey were formed at random by a computer programmed to ensure that each area of the state was represented in proportion to its population. The results based on responses from all 773 most likely voters have a margin of sampling error of 3.5 percentage points. That means if the New York Times newspapers in Florida asked every voter in the state the same questions, in most cases, the results would be within 3.5 percentage points of the results obtained by the survey. Interviewers used a series of three questions to determine voters who were most likely to go to cast their ballots Tuesday. In questions where only the answers of smaller groups are used, the margin of sampling error is larger. For example, the margin of sampling error for just registered Democrats or only registered Republicans will be higher.

In addition to sampling error, the practical difficulties of conducting any poll can induce other forms of error.

Source: *The Gainsville Sun*, October 30, 1992

Presidential Race in Florida Too Close to Call



Source: The Florida Opinion Poll, October 24–27, 1992

STUDENT PAGE 43

Discussion and Practice

1. Who conducted the poll? Do you think they had a special interest in the outcome?
2. What main questions did the survey address?
3. What was the population?
4. Did the article describe a census or a sample survey?
5. How was the sample selected?
6. How large was the sample?
7. How were the data presented?
8. How were the data analyzed?
9. Were the conclusions stated fairly in light of the original question?
10. What would you like to know that was not reported?
11. a. What questions might have been asked to determine if a person were a "likely" voter?
    b. How do you think randomization might have been accomplished?
    c. Why was the state divided into areas, with randomization done within the areas?
    d. How do you think 773 was chosen as the number of people to be surveyed?

Information was collected by telephone conversations. The question was straightforward, so bias does not appear to be a problem. The data are nicely summarized using percents and presented on a pie chart. Little analysis is presented beyond this summary. The principle conclusion is that the race between Bush and Clinton was too close to call.

Practice and Applications

12. Why would the pollsters make the conclusion that the race was too close to call when it is clear that Bush had the highest percentage of votes in the sample?
13. What would you change if you were doing the survey?
14. Problems 1–10 in this lesson cover all the important points of a critique. Use them to help you write a critique of the poll.
15. Use a printed article that contains the results of a survey. Write a critique of the article.

Solution Key

Discussion and Practice

1. The *New York Times* newspapers in Florida conducted the survey. Bias can result if the person or group conducting the poll has a political affiliation. No special interest seems to be shown here nor would the pollsters gain anything from favorable results.

2. The poll attempted to answer the question of who would win the presidential race if it were held on October 30, 1992. The specific question asked was, "If the presidential election were today, would you vote for George Bush, Bill Clinton, or Ross Perot?" Secondary questions dealt with subgroups of voters, such as conservatives versus liberals and Republicans versus Democrats. Such questions allow you to make comparisons and connections among subgroups of the population.

3. The population under study here was not the entire population of Florida nor even the entire population of registered voters in Florida. It was the population of voters most likely to go to the polls on election day. Whether or not a voter falls into this population was determined by a series of questions not presented in the article.

4. The article describes a sample survey.

5. The sample was chosen by randomly selecting telephone numbers from different areas of the state.

6. The sample size was 773.

7. The data were presented both by describing the results of the survey in words and by showing a pie chart.

8. First, the findings were given. These were compared and percents were given for each category. The percents were then compared. The margin of error was given. It was pointed out that if the margin of error were added or subtracted from the percents of the various candidates, this could tie the results. Therefore, the result of the survey was that the election was too close to call.

9. There did not appear to be bias in the results, if randomization was truly achieved. Therefore, it appears the conclusions were fairly stated.

10. You might want to know what questions were used to determine if a person is likely to vote. The students may come up with other questions of interest to them.

11. **a.** People were probably asked how many times they have voted in the last number of years.

b. Telephone numbers were formed at random by a computer. Each area of the state was represented in proportion to its population, probably through area codes.

c. Certain ethnic or age groups may reside in a specific part of the state. To make sure all groups were equally accounted for, people from areas were selected according to their proportion of the total.

d. 773 was the number of likely voters.

Practice and Applications

12. The 3% margin of error could have meant all three percent votes were going to be Clinton votes. In that case, Clinton would have had a higher percentage of votes than Bush had.

13. Answers will vary. The poll seems to have been fair.

14. Critiques should include the information listed in the lesson.

- The survey was conducted by the *New York Times* newspaper in Florida. Their particular interest was getting news on the upcoming election.
- The main question was, "If the presidential election were today, would you vote for George Bush, Bill Clinton, or Ross Perot?" There was no bias involved.
- The population of interest was those most likely to vote on election day in Florida.
- This was a sample survey.
- There was randomization as described in part b of question 11.
- The sample consisted of 773 people surveyed.
- Findings were listed in print and also shown on a pie chart.
- The findings were discussed as were the differences when only Democrats or only Republicans were surveyed.
- The conclusions seemed fairly stated.
- The report answered the question well. Students may have other areas about which they would like to know.

15. Answers will vary. Be sure students include a copy of the article and give the source from of the article.

LESSON 9

Understanding Sampling Error

Materials: none
Technology: 4-function or scientific calculators
Pacing: 1 class period

Overview

This lesson is provided for those students who wish to investigate sampling error. The margin of error or sampling error tends to decrease as sample size increases. Sampling error accounts for the variability in taking samples.

Teaching Notes

This lesson is divided into two sections. Problems 1, 2, and 3 deal with sampling error in general. Problems 4–10 deal with a specific article and then generalize from that article. Students who have studied statistics may be familiar with sampling error. The formula for sampling error for a sample proportion is a function of the proportion and the sample size. If your students have studied sampling error, they should be able to complete Problems 7–10. If not, you may want to stop the lesson at Problem 6. The students must know some basic algebra to be successful with this lesson. They must know how to substitute in an equation and how to do simple work with square root.

Solutions

Discussion and Practice

1. **a.** The sampling error could be close to 1.0 – 0.4 = 0.6 if nearly all the students like the cafeteria food.

b. The sampling error is 0 if the population proportion equals the sample proportion of 0.4.

STUDENT PAGE 44

LESSON 9

Understanding Sampling Error

How do you know how well a sample reflects the population?

Is there any way to tell?

OBJECTIVES

Identify characteristics of sampling error.

Compute sampling error.

Randomization is used in selecting samples to ensure that the samples have a good chance of accurately representing the population from which they were selected. The sample data will not, however, look exactly like the population data.

INVESTIGATE

Sampling Error

How can you tell, then, how close sample quantities will be to their corresponding population quantities? In general, this is a difficult question, but there is a reasonably simple answer if proportions are used. The answer will be given after you've had a little practice thinking about *sampling error*.

Discussion and Practice

1. Suppose you randomly sample 50 students from your school and find that 20 of the 50, or 40%, like the cafeteria hours. The sampling error is the difference between this sample proportion of 40% and the true proportion of students in your school who like the cafeteria hours.

a. What is the maximum value the sampling error could be?

b. What is the minimum value the sampling error could be?

2. The best choice is part a. It would be quite unusual to have the population proportion close to 1 and yet have a sample proportion of only 0.4 in a random sample of size 50.

3. **a.** No; the sampling error will be less than 3% approximately 95% of the time such sample sizes are used.

b. The true percentage who think the school year should be lengthened is estimated to be between 37% and 43%. Most likely the results will be here, but there is a chance it will be out of this interval.

4. **a.** No; the sampling error for random samples of size 1,000 will be less than 4% approximately 95% of the time this sample size is used.

STUDENT PAGE 45

2. What if you did many school surveys? Each time, you ask only a sample of students out of the entire student body. You will have different sampling errors. For these sampling errors, will most of them be

- **a.** close to the minimum you selected?
- **b.** close to the maximum you selected?
- **c.** evenly distributed between the minimum and the maximum?
- **d.** Explain your reasoning.

Read the following article from the June 5, 1985, *New York Times*. A *New York Times*/CBS News poll was based on interviews conducted May 29, 1985, through June 2, 1985, with 1,500 adults around the United States, excluding Alaska and Hawaii.

> The sample of telephone exchanges called was selected by a computer from a complete list of exchanges in the country. The exchanges were chosen to insure that each region of the country was represented in proportion to its population. For each exchange, the telephone numbers were formed by random digits, so both listed and unlisted residential numbers could be called.
>
> In theory, in 19 cases out of 20, the results based on such samples will differ by no more than 3 percentage points in either direction from what would have been obtained by interviewing all adult Americans. In other words, the difference between the sample percentage and the population percentage is less than 3% with probability $\frac{19}{20}$ or .95.

The article from the *New York Times* states that, in addition to sampling error, the practical difficulties of conducting any survey of public opinion may introduce other sources of error into the poll.

3. **a.** For random samples of size 1,500, will the sampling error always be less than 0.03? Explain.

- **b.** Suppose a *New York Times* poll says that 40% of the 1,500 people interviewed think the school year should be lengthened. What can you say about the true percentage of Americans who think the school year should be lengthened?

4. Read the part of the Gallup Poll article from Lesson 7 dealing with sampling error, called *sampling tolerances*.

- **a.** For random samples of size 1,000, will the sampling error always be less than 4%? Explain.

(4) b. The true percentage who think the school year should be lengthened is estimated to be between 36% and 44%.

5. The sampling error tends to decrease as sample size increases.

6. a. $\frac{1}{\sqrt{1,500}}$ = 0.026, slightly less than the reported 0.03.

$\frac{1}{\sqrt{1,000}}$ = 0.032, slightly less than the reported 0.04.

The polls are conservative in their reporting of potential sampling errors.

b. $\frac{1}{\sqrt{50}}$ = 0.14. The sampling error could be 14%.

STUDENT PAGE 46

b. Suppose a Gallup poll says 40% of the 1,000 people interviewed think the school year should be lengthened. What can you say about the true percentage of Americans who think the school year should be lengthened?

5. Refer to both the *New York Times* and Gallup statements on sampling error and explain how sampling error is affected by the sample size.

6. A handy rule of thumb for sampling error when estimating proportions through random samples is that sampling error will be less than $\frac{1}{\sqrt{n}}$ about 95% of the time.

- **a.** Is this rule of thumb consistent with the *New York Times* and Gallup Poll statements on sampling error?
- **b.** In Question 1, your poll involved only 50 students. What would you estimate the sampling error to be in a poll of this size?

You are now going to investigate the formula for sampling error. Refer to the article in Lesson 8 on a typical election poll. To understand that Bush has the highest percentage of votes in the sample but that the conclusion is too close to call requires study of the "margin of sampling error." From earlier studies of statistics and probability, you may recall that sample proportions will vary from sample to sample according to a definite and predictable pattern (in the long run). In fact, 95% of all sample proportions will fall within two standard deviations of the true population proportion. If a sample proportion is denoted by p, then the standard deviation of the sample proportions is given by

$$\sqrt{\frac{p\,(1-p)}{n}}$$

and 95% of the potential sample proportions will fall within

$$2\sqrt{\frac{p\,(1-p)}{n}}$$

of the true population proportion. This two-standard-deviation interval is the *margin of sampling error.* Substituting 0.39, the percent support that Bush received, for p and 773 for n results in a calculated margin of error equal to 0.035. Thus, the true proportion of voters favoring Bush may well be anywhere in the interval 0.39 – 0.035 to 0.39 + 0.035, or (0.355, 0.425).

STUDENT PAGE 47

7. **a.** Find the corresponding two-standard-deviation interval for Clinton.

b. Explain why the pollsters do not want to call this race.

c. Find the corresponding interval for Perot.

d. Why did the writers of the article report only one value for the margin of error?

8. Notice that the sample size is the denominator of the margin of sampling error formula.

a. Would increasing the number in the sample size reduce the margin of error? Explain why or why not.

b. Look back at one of the surveys you conducted earlier in this unit. Find the margin of error for a proportion in that survey and then find the sample size that would be required to cut this margin of error in half.

9. Study the article in Lesson 8 carefully to determine the breakdowns of the percentages among conservative, moderate, and liberal voters.

a. Is there any way to attach a margin of sampling error to these percentages?

b. If you could find these margins of error, would they be greater or less than 0.035?

c. Can you attach a meaningful margin of error to the percentage of Democrats and Republicans who backed Clinton?

10. It would be nice to know more about the sampling scheme used in that political poll.

a. How do you think randomization might have been achieved?

b. Do you think the questions that were used or the phone calls that were rejected might have caused a bias in the results?

7. **a.** For Clinton, $p = 0.37$ and $n = 773$. The margin of sampling error is 0.035, which means the proportion of voters favoring Clinton was anywhere in the interval $0.37 - 0.035$ to $0.37 + 0.035$ or (0.335 to 0.405).

b. Bush intervals go from 0.355 to 0.425 and Clinton intervals go from 0.335 to 0.405. There is a great overlap in these intervals and so no clear winner could have been selected.

c. For Perot, $p = 0.21$ and $n = 773$. The margin of sampling error is 0.029, which means the proportion of voters favoring Perot may well have been anywhere in the interval from $0.21 - 0.029$ to $0.21 + 0.029$ or (0.181 to 0.239).

d. The margin of error is the same value, 0.035, for both leading candidates. It is smaller for Perot, but the more conservative value is usually reported.

8. **a.** If the number interviewed were 1,000 instead of 773, the margin of error for Bush would be 0.030 instead of 0.035. As the denominator increases (that is, the number of people polled increases), the margin of error decreases.

b. To cut the margin of error in half, the sample size must be multiplied by four.

9. **a.** There is no information given on the number of conservative, moderate, and liberal voters. Therefore, a margin of error cannot be calculated.

b. The margins of error would be larger than 0.035 because the sample size would be smaller.

c. The article states 51% of the voters were registered Democrats and 41% were registered Republicans. For a random sample, you expect the percentage in the sample to be close to the percentages in the population. Thus, about 773 (0.51) = 394 sampled voters should have been Democrats. The article says 61% of Democrats backed Clinton. So the margin of error is

$$2\sqrt{\frac{(0.61)(0.39)}{394}} \approx 0.049.$$

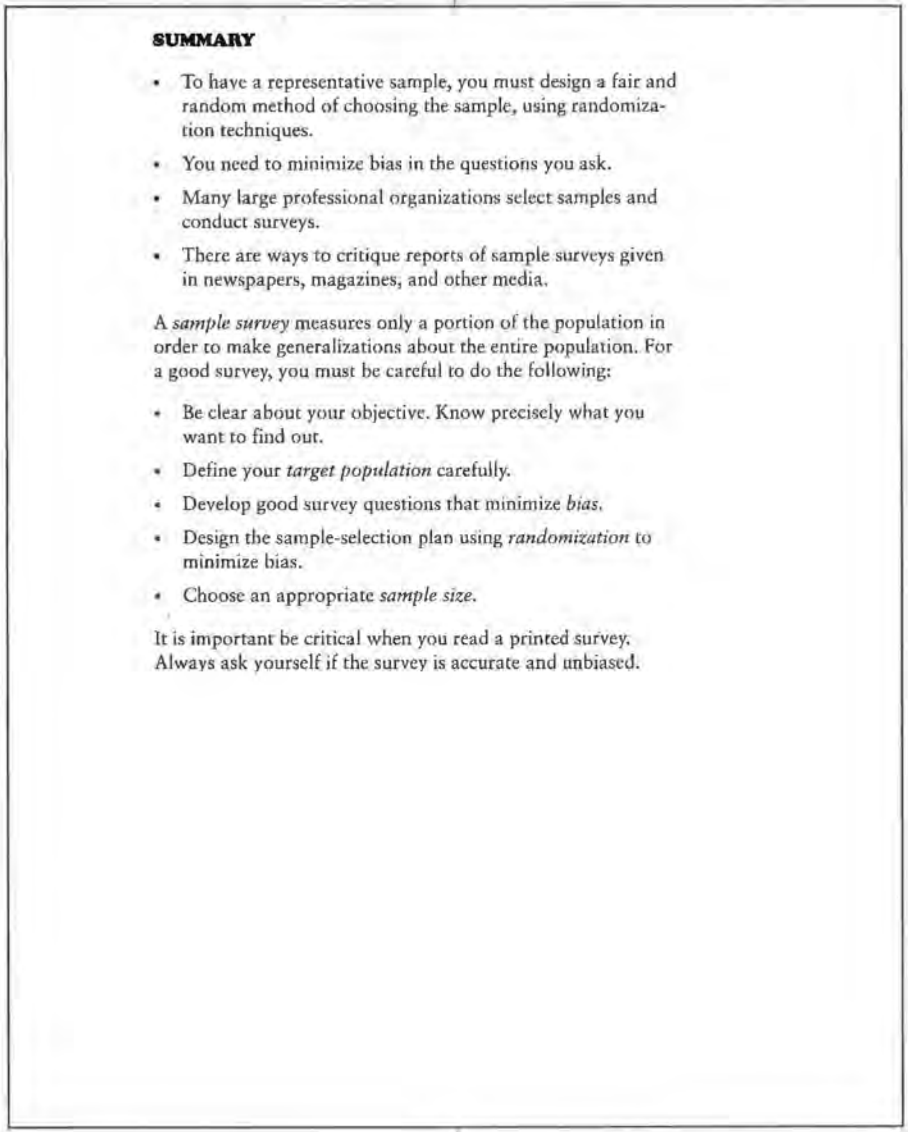
About 773(0.41) = 317 sample voters should have been Republicans, 12% of whom backed Clinton. So the margin of error is

$$2\sqrt{\frac{(0.12)(0.88)}{317}} \approx 0.036.$$

10. **a.** Telephone numbers, within exchanges, were probably formed and dialed at random by a computer.

b. The fact that data came only from people willing to answer the phone and answer the questions could have caused some bias.

STUDENT PAGE 48



SUMMARY

- To have a representative sample, you must design a fair and random method of choosing the sample, using randomization techniques.
- You need to minimize bias in the questions you ask.
- Many large professional organizations select samples and conduct surveys.
- There are ways to critique reports of sample surveys given in newspapers, magazines, and other media.

A *sample survey* measures only a portion of the population in order to make generalizations about the entire population. For a good survey, you must be careful to do the following:

- Be clear about your objective. Know precisely what you want to find out.
- Define your *target population* carefully.
- Develop good survey questions that minimize *bias*.
- Design the sample-selection plan using *randomization* to minimize bias.
- Choose an appropriate *sample size*.

It is important be critical when you read a printed survey. Always ask yourself if the survey is accurate and unbiased.

UNIT II ACTIVITY

Conducting Your Own Survey

Materials: *Activity Sheet 4*
Technology: graphing calculators and computers (optional)
Pacing: 1 day to several weeks at your discretion

Overview

The suggested activities provide students with practice designing and conducting surveys.

Teaching Notes

The topics listed are just suggestions; students may select their own, but it is a good idea to have them receive your approval before they begin. Students may work individually, in pairs, or in groups. They can carry out the survey in several days or over several weeks depending on class schedule. One way to evaluate the results is to have each group report to the class and have the class members assign a score to the report based on an agreed-upon rubric. Compile the scores for the final grade. Suggestions for evaluation from the section on *Assessment Ideas*, pages 121–124, might also be useful here.

Technology

Students may choose to do their analyses and graphs using technology. Be sure they turn in hard copies. Encourage them to use a word processor for their reports.

STUDENT PAGE 49

UNIT II ACTIVITY

Conducting Your Own Survey

OBJECTIVE

Practice designing and conducting surveys.

You have read about surveys. Now try your hand at one. The Statistical Sample Survey Plan on *Activity Sheet 4* will help you get started. Further help in working through your survey is offered in Unit 4 of this module.

Survey Ideas

1. Favorite NFL, NBA, NHL, or NCAA team at your school
2. Trends in clothing, including styles, shoe types, and brand names
3. Students' food preferences
4. Family issues, such as required chores, dating rules, and allowances (You can compare what goes on in your family to families of other students at your school.)
5. Political preferences, particularly at election time
6. Religious and moral issues, such as feelings about abortion, birth control, cheating, or prejudice
7. School issues, such as dress codes, school rules, and cafeteria menus

Remember the concepts you learned in this unit as you plan your survey. Keep the concept of bias in mind when you decide on your survey questions, and remember that randomness is very important when selecting your sample.

UNIT III

Experiments

LESSON 10

Conducting an Experiment

Materials: clock with a second hand visible to all students; self-adhesive notes; butcher paper, adding-machine tape, or other material to make a number line on the wall
Technology: none
Pacing: 1 class period

Overview

This is an introductory lesson about experiments and is intended to raise questions and issues. Students should realize that an experiment must be well-planned and organized prior to collecting any type of data. By collecting data without carefully thinking about what variables are important, students come to realize their data are not very useful.

Teaching Notes

As class begins, have students find their pulse rates. Do not give advance warning to students—you want them to see that this is not an experiment; it's just a way of collecting background data. It is essential to conduct an experiment under controlled conditions, and this is *not* what you are doing.

The data collected do, however, pose interesting questions. Based on the extremes your class generates, create a number line with intervals about 1 foot apart. The tiles on the floor are a helpful guide. Have students stand where their pulse rates fit in this "human line plot." Students should have the questions with them as they stand in the plot. They will need to take notes on the first question. The rest of the questions can be done in their groups.

Student will struggle with the definition of an athlete. As a class, come to some consensus or analyze the data using different definitions and compare the results.

STUDENT PAGE 53

LESSON 10

Conducting an Experiment

What is an experiment?

Do surveys and experiments have anything in common?

OBJECTIVES

Conduct an experiment, and reflect on the results.

Analyze data for clusters, gaps, and outliers.

Make graphs from collected data.

An *experiment* is different from a survey. In an experiment, the objective is to see if a set of experimental units treated one way behave differently from a set of similar experimental units treated another way. For example, does a heated tennis ball bounce higher than a cold one? The objective of a survey is to estimate certain characteristics of a population, such as how many people hold a certain opinion.

Just as in a survey, an experiment must involve a good data-collection plan. If you want to find out how many times a ball bounces before it comes to rest, you bounce a ball and count the bounces. If you want a measure of how fast an ice cube freezes, you put water into the freezer and determine the length of time it takes to freeze. Both of these are experiments you might repeat several times to be sure you have consistent results.

INVESTIGATE

Checking Pulses

Everyone should find his or her own pulse rate and record the number of heartbeats per minute.

You will then use the collected data for your class to make two visible displays of the data. One will be a human line plot, and the other will be a sticky note (such as Post-it™) line plot on a wall.

STUDENT PAGE 54

Discussion and Practice

Your teacher will make a number line along one side of the room. When instructed to do so, bring your pencil and the sticky note you have been given to the number line. Place the note on the wall over the number that corresponds to your pulse rate. Then, stand in front of the line at the number that corresponds to your pulse rate. When the class has completed this task, you will answer several questions.

1. Use the class data to answer each question.

  a. What was the highest pulse rate? What might account for that?

  b. What was the lowest pulse rate? What might account for that?

  c. Where are the clusters and gaps in the line plot?

  d. Do there appear to be any outliers in the line plot?

  e. Where does the line plot appear to center?

  f. What other observations can you make about the shape of the line plot?

2. Consider the process used in making the measurements.

  a. How did you count? Did everyone count for a full minute?

  b. Is it better to count for a full minute or to count for 15 seconds and multiply by 4?

  c. Discuss other possibilities for measuring pulse rate.

  d. Come to a consensus on how to measure pulse rate.

Practice and Applications

3. Take your pulse rate again, using the measurement method decided upon by the class.

  a. Are your results the same as the first time? Why might the two measurements for the same person differ?

  b. Suppose a student just came from gym class. Where might that student's pulse rate fit on the line plot and why?

  c. Suppose a student is late for class. Where might that student's pulse rate fit on the line plot? Explain.

Solution Key

Discussion and Practice

1. **a.** The range within the class will vary. Differences in pulse rates might be due to students' coming from gym class or running up the steps so they wouldn't be late, weight (a sensitive issue), or physical fitness.

b. Same answer as part a.

c. Answers will vary. Clusters are data points that are grouped together. Gaps are spaces between data points.

d. Answers will vary. Outliers are data points that lie far away from most of the other data points.

e. You may want to discuss the mean and the median. This might be a good time to show how the mean is affected by outliers.

f. Answers will vary. The distribution is usually quite mound-shaped and symmetrical.

2. **a.** There are a variety of ways to calculate pulse rate. Students will respond with a variety of answers from counting for a minute to counting for 15 seconds.

b. Students' responses may differ. Counting for 15 seconds and multiplying by 4 may mean fewer miscounts. Counting for a full minute may be more accurate.

c. Other possibilities include counting for 30 seconds and multiplying by 2 or counting for a full minute.

d. The class will make a decision as to the way pulse rate will be measured.

Practice and Applications

3. **a.** Answers will vary. Different measurements could be due to the new method or to miscounting the first time.

b. The student's pulse rate would probably be high on the line plot due to the physical activity usually associated with a gym class.

c. The student's pulse rate might be high on the line plot if he or she probably ran to class in an attempt to be on time. On the other hand, the student's rate could be low if he or she walked slowly to class, not caring about the time.

(3) d. The student's pulse rate would probably be low on the line plot. He or she probably did not rush from next door to class.

4. a. Probably not. Perhaps only males came from gym and females did not. Thus, we could not tell if high pulse rates were due to rushing to class or to gender.

b. Answers will vary, but unplanned data usually do not provide good answers to specific questions.

STUDENT PAGE 55

d. Suppose a student just came from a class next door. Where might that student's pulse rate fit on the line plot? Explain.

4. Make a plot based on the data you collected.

a. From the data you collected, can you obtain a good answer to the question of whether or not those who came from gym class tend to have higher pulse rates than those who came from the classrooms nearby? Why or why not?

b. Pose other questions you might like to answer. Do you think the data already collected would provide a good answer for these questions?

LESSON 11

Experimenting to Answer a Question

Materials: clock with a second hand visible to all students
Technology: graphing calculators (optional)
Pacing: 1 class period

Overview

In this lesson, students learn to conduct an experiment. An experiment is a carefully developed plan that considers all of the variables surrounding a question, controls some of them, and investigates what happens as the others are systematically varied. Students redo the pulse-taking activity, but this time they begin with a specific question, consider the variables, control those they can, and choose one variable as a treatment. For example, to study the effect of cholesterol on heart function, physicians may control gender, weight, and age, and then assign one group to a low-cholesterol diet while others remain on their regular diets. Amount of cholesterol in the diet is the treatment, while some technical measure of heart function is the response.

Teaching Notes

The question of interest is whether a longer period of exercise has more effect on pulse rate than a short period, and whether the effect of period length differs between athletes and nonathletes. In the *Investigate* part of the lesson, students are asked to exercise for one minute and then for three minutes. If all students exercise for one minute and a few minutes later exercise for three minutes, you are really answering a different question about consecutive exercise periods. The pulse rates may be different and skew the data. To control the effect of being athletic and more accustomed to exercise, students must first define what *athletic* means. Some will select only those who engage in regular supervised athletic activities (baseball, track, basketball, tennis). Ask questions such as, "Are those who jog or ski for recreation athletic?" Once the issues are resolved, half of those classified as athlete and half of those classified as nonathlete should be randomly assigned to each group.

According to the medical profession, the best way to find your pulse rate is to count for 15 seconds and then multiply by 4. The following formulas are estimates for any age and for either sex. Minimal aerobic heart rate is (220 minus your age) times 0.7. The maximal aerobic heart rate is (220 minus your age) times 0.85.

Follow-Up

As an extension, you might ask students to bring in examples of experiments performed in science classes, so that the class can discuss the key elements in the design. Or, you might check with science teachers to get information on these experiments.

STUDENT PAGE 56

LESSON 11

Experimenting to Answer a Question

What makes a good experiment?

Why do people conduct experiments?

OBJECTIVE

Design and conduct an experiment to answer specific questions.

One key variable in an experiment is the response in which you are interested, such as pulse rate. If you want to study the effect of exercise, then the variable "exercise" is called a *treatment* and is intentionally set at different levels. Other variables that might affect the response, such as gender, are balanced across treatments in the design.

Consider the following example and think about the elements involved in carrying out a good experiment.

Does listening to radio music while doing homework help or hinder? What variable might affect the outcome? A carefully planned experiment can help to answer specific questions like this. What is the response? Help or hinder what? This question could be made more specific by choosing to measure scores on a history quiz as the response of interest.

This experiment has one treatment—status of the radio, with two levels: the radio is on or the radio is off. Some students are directed to study with the radio on and some with the radio off. Treatment levels are to be compared by scores on a history quiz given to all students in the experiment.

There are other variables that might affect the outcome, as well. Perhaps those who study in the afternoon learn more than those who study in the evening. The effect of time of day can be eliminated by having all students study in the evening. Perhaps girls do better than boys in this course. The effect of gender can be balanced by having equal (or nearly equal) numbers of girls at each treatment level. Then the difference in

STUDENT PAGE 57

average score for the two treatment groups cannot be attributed to gender. You are controlling for gender. Ability levels could affect outcomes. Even though all students might be from the same-level history class, there are still differences in ability. Since it is difficult to directly control the assignment of students based on ability, you could randomly assign boys and girls to the treatments. This should help to balance out any differences in ability among the students.

INVESTIGATE

Key Elements in an Experiment

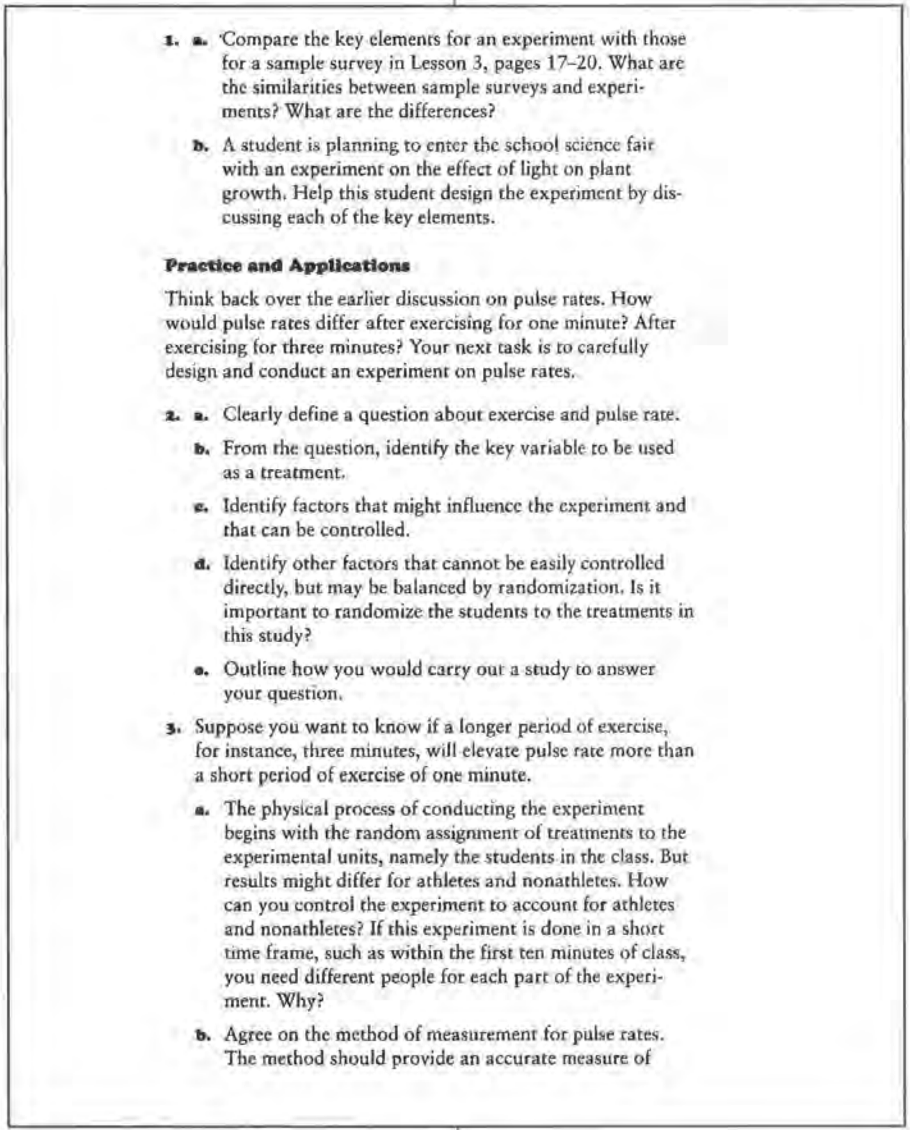
The key elements to be considered in any experiment are listed below.

- Both the question to be investigated and the response variable must be clearly defined.
- Key variables to be used as treatments must be identified.
- Other important variables that can be controlled directly must also be identified.
- Important background, or *lurking*, variables that *cannot* be controlled directly should be identified and then balanced by randomization.
- Treatments should be randomly assigned to the experimental units.
- The method of measurement should minimize measurement bias. (Measurement bias will be discussed in the next lesson.)
- Data collection and data management should be organized.
- Careful and thorough data analysis should be included.
- Conclusions should be written in light of the original question.
- A follow-up study to answer the question more completely or to answer the next logical question about the issue should be planned.

Discussion and Practice

To determine why the key elements are important, answer the following questions.

STUDENT PAGE 58



1. a. Compare the key elements for an experiment with those for a sample survey in Lesson 3, pages 17–20. What are the similarities between sample surveys and experiments? What are the differences?

   b. A student is planning to enter the school science fair with an experiment on the effect of light on plant growth. Help this student design the experiment by discussing each of the key elements.

Practice and Applications

Think back over the earlier discussion on pulse rates. How would pulse rates differ after exercising for one minute? After exercising for three minutes? Your next task is to carefully design and conduct an experiment on pulse rates.

2. a. Clearly define a question about exercise and pulse rate.

   b. From the question, identify the key variable to be used as a treatment.

   c. Identify factors that might influence the experiment and that can be controlled.

   d. Identify other factors that cannot be easily controlled directly, but may be balanced by randomization. Is it important to randomize the students to the treatments in this study?

   e. Outline how you would carry out a study to answer your question.

3. Suppose you want to know if a longer period of exercise, for instance, three minutes, will elevate pulse rate more than a short period of exercise of one minute.

   a. The physical process of conducting the experiment begins with the random assignment of treatments to the experimental units, namely the students in the class. But results might differ for athletes and nonathletes. How can you control the experiment to account for athletes and nonathletes? If this experiment is done in a short time frame, such as within the first ten minutes of class, you need different people for each part of the experiment. Why?

   b. Agree on the method of measurement for pulse rates. The method should provide an accurate measure of

Solution Key

Discussion and Practice

1. **a.** Similarities between an experiment and a sample survey:

- The question must be clearly stated in both cases.
- Both try to minimize measurement bias.
- Both use randomization.
- Both organize data collection and data management.
- Both plan for careful and thorough data analysis.
- Both write conclusions based on the original objectives.

Differences between an experiment and a sample survey:

- In a survey, you define the target population. In an experiment, you identify the key variables used as treatments and variables that can be controlled directly.
- In a survey, you randomly select the sample. In an experiment, you randomly assign treatments to the experimental units.

b. Student responses will vary. They might consider the question, "Does light affect plant growth?" The variables could be length of time in light, degree of light, type of plant, amount of water given, and age of plant. Controlling for age, type of plant, and water, they might assign a treatment where half of the plants are given a certain number of hours of sunlight in an eastern window and half given the same number of hours of sunlight in a southern window. The measurement would be the amount of growth in the plants throughout the experiment.

Practice and Applications

2. **a.** Does exercise affect pulse rate?

b. Amount of exercise is the key variable. The experiment has been designed for one-minute and three-minute exercise periods.

c. Athlete/nonathlete; male/female

d. Health, individual fitness, nerves, and weight are possible variables. It is important to randomize.

e. Answers will vary.

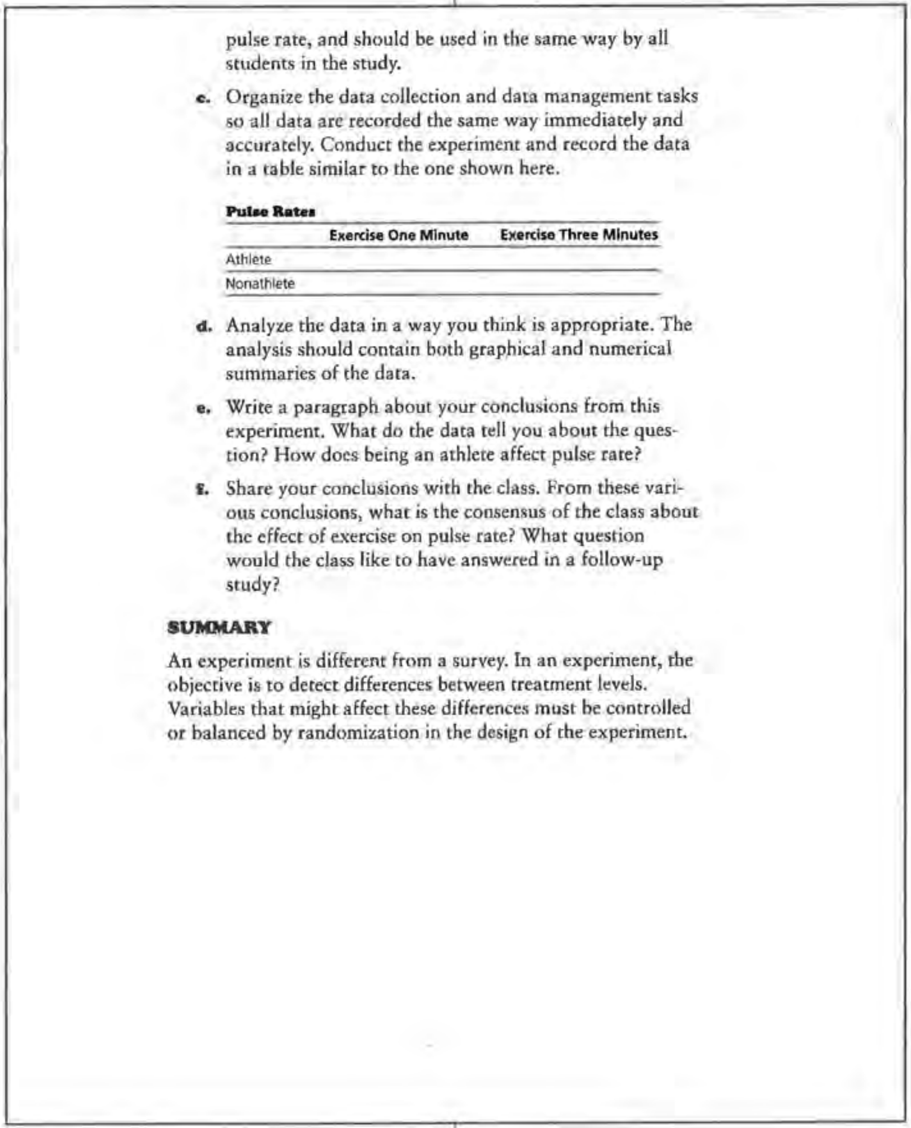
3. **a.** Athletes and nonathletes need to be randomly assigned to each exercise group, so a comparable number of each type is in each group. Point out to students that if the experiment is done in a short time frame, different people are needed in each group. Those exercising one minute would have to return to their normal pulse rates before exercising for three minutes.

A quicker way is to randomly assign athletes and nonathletes to the one-minute and the three-minute groups.

b. Physicians suggest timing and counting for 15 seconds and then multiplying by 4, but counting for 30 seconds and multiplying by 2 provides a better set of numbers.

c.–f. Answers will vary.

STUDENT PAGE 59



pulse rate, and should be used in the same way by all students in the study.

c. Organize the data collection and data management tasks so all data are recorded the same way immediately and accurately. Conduct the experiment and record the data in a table similar to the one shown here.

Pulse Rates

	Exercise One Minute	Exercise Three Minutes
Athlete		
Nonathlete		

d. Analyze the data in a way you think is appropriate. The analysis should contain both graphical and numerical summaries of the data.

e. Write a paragraph about your conclusions from this experiment. What do the data tell you about the question? How does being an athlete affect pulse rate?

f. Share your conclusions with the class. From these various conclusions, what is the consensus of the class about the effect of exercise on pulse rate? What question would the class like to have answered in a follow-up study?

SUMMARY

An experiment is different from a survey. In an experiment, the objective is to detect differences between treatment levels. Variables that might affect these differences must be controlled or balanced by randomization in the design of the experiment.

LESSON 12

Measurement Variability and Bias

Materials: rulers and yardstick; two different-sized pieces of string measuring between 36 and 48 inches; staples, scissors, and glue for each group; *Activity Sheet 5* copied on cardstock or stiff paper for each group
Technology: graphing calculators (optional)
Pacing: 1 class period

Overview

Regardless of how carefully students measure, there will be variability in the measures they get. Occasionally, there is bias in the measurement. When a measurement is biased, the result will vary from the true measurement by a predictable amount. Random variability cannot be predicted. Students should be aware that such bias exists, learn how to identify it, and find out as much as possible how to overcome any such bias.

Teaching Notes

After students complete part a of Problem 1, ask five students to actually measure the desk using the ruler or meter stick. Have each one write the results so the others who measure will not be influenced by the measures of the other students. The five students will probably get different measurements.

For Problem 2, you will need two strings of different lengths between 40 and 48 inches. Students' estimates are biased and you can predict ahead of time that most estimates will be too low. As in most cases in statistics, you are not analyzing the responses of a given individual, but rather looking at the overall patterns. Have students write down their estimates for both string lengths on pieces of paper. Then collect the papers and read and record the results. If students report their own estimates aloud and theirs are very different from the other estimates, they may adjust theirs to "fit" the others.

Group students to work on Problems 3 and 4. Before the lesson, make copies of *Activity Sheet 5* on cardstock or stiff paper, and give a copy to every group.

Solution Key

Discussion and Practice

1. **a.** The following are some reasons why measurements probably differ:
   - If using a 12- or 6-inch ruler, error can occur when marking each ruler movement.
   - Some students will not measure parallel to the edge. A slight slant will throw off the data.
   - If using a string to measure and then a ruler, error can occur due to the elasticity of the string.
   - Some students may not know how to measure to the nearest quarter of an inch.

   b. The variability in measuring pulse rate has two main sources, the counting method used and the fact that pulse rates actually vary from person to person and time to time. The variability in your desktop is due entirely to the measuring instrument and techniques used by different people.

STUDENT PAGE 60

LESSON 12

Measurement Variability and Bias

While surveys can be biased, is it possible to have biased experiments?

What is the main cause of bias in experiments?

OBJECTIVES

Understand that all measurement processes are subject to variability and bias.

Estimate lengths and measure in inches and quarter inches.

Graph and interpret collected data.

When you do an experiment, you must think about the variables that might affect the outcome.

INVESTIGATE

Recall from Lesson 11 some of the variables that might affect the outcome of the pulse-rate experiment. Others might include room temperature, time of day, and type of clothing students are wearing.

Discussion and Practice

1. The pulse rates of students in the class produced a line plot that showed variability in the data. That was not surprising, since students differ in physical size and condition as well as in emotional status at the time the pulse was taken. Now, suppose five students measure the length of the teacher's desk to the nearest quarter inch. Would all five get the same measurement?
   a. Discuss whether or not all five students would tend to get the same measurement of the length of the teacher's desk, and why or why not. Record your conclusion.
   b. Describe the differences between the variability produced by the pulse-rate measurements and the variability obtained by the measurements of desk length.

STUDENT PAGE 61

c. Suppose the students measure the desk length with a yardstick that has a fraction of an inch worn off both ends. In addition to being variable, what other feature will the desk-length measurements possess?

d. Measurements that *systematically and regularly deviate from the truth in one direction or another* are said to be *biased.* Provide examples of typical measurement processes you think might be biased.

Practice and Applications

2. Estimate the length, to the nearest inch, of the two strings your teacher is holding.

a. The first string, string A, is about ______ inches long.

b. The second string, string B, which is at least 36 inches long, is about ______ inches long.

3. When instructed to do so, record your "measurements" on numbered line plots for the class data, one plot for each string.

a. Describe any patterns you see in the data from string A.

b. Describe any patterns you see in the data from string B. What are the differences between the patterns for the length of string A and that of string B?

c. The teacher will provide the correct lengths for each string. How did the estimated lengths compare to the true lengths?

d. Make a general statement about variability and bias in these processes for "measuring" string length. Can you suggest possible reasons for the bias, if it exists?

4. For this activity, each group will use *Activity Sheet 5.*

a. Construct the card, following the directions given on the *Activity Sheet.*

b. Each member of the group should do the following. Pull the slide until the line on the slide looks as if it is the same length as the line on the face of the card, or jacket. Then, turn the jacket over and read the length of the extended line from the ruler on the back. Record this measurement without revealing it to the other members of the group.

---

(1) c. The students will probably not realize the yardstick is worn at both ends, so the measurements will probably be shorter than the actual length. In addition to being variable, the measurement will be biased.

d. A few examples of typical measurement processes that might be biased are:

- weight of a quarter pound of hamburger
- a 16-ounce soda at the theater
- yardage at a fabric store

Practice and Applications

2. a.–b. Answers will vary. The estimated lengths will probably vary greatly. Frequently, students will underestimate the length.

3. a.–b. Answers will vary. The lengths will probably cluster within a small range of values. The estimates for string A will vary more than the estimates for string B because students are told that it is at least 36 inches long.

c. Answers will vary. The estimates for string A will probably be low. The guesses for string B will probably be closer to the true length.

d. A possible reason for bias could be that people think in terms of a yard as a standard measurement. They do not want to guess too much over 1 yard.

4. Students should follow the instructions and outline on *Activity Sheet 5* to construct an optical-illusion device.

a. Students should cut out and assemble the pieces so the slide moves freely inside the jacket.

b. The object is to pull out the slide until the line on the slide is the same length as the line on the front of the jacket. The length of the line on the slide can be measured by simply turning over the device and reading the measurement on the back, in centimeters.

c.–d. After everyone in the class has made a measurement from the slide, make a plot of these data. A line plot works well here. Then have a student measure the length of the line on the front of the jacket. Mark this value on the plot and discuss the results. Data may be quite variable, but most of the students' measurements will be shorter than the line on the front. This is an example of bias caused by an optical illusion. Even if you tell the students they are likely to be short, they usually do not compensate enough.

5. a. The lengths collected of the extended line tend to vary. This indicates there is variability in viewing estimates.

b. The lengths collected tend to be too short.

6. Other examples of measurement bias might be:

- measuring the length of a perceived minute
- guessing the height of a tall building or tree

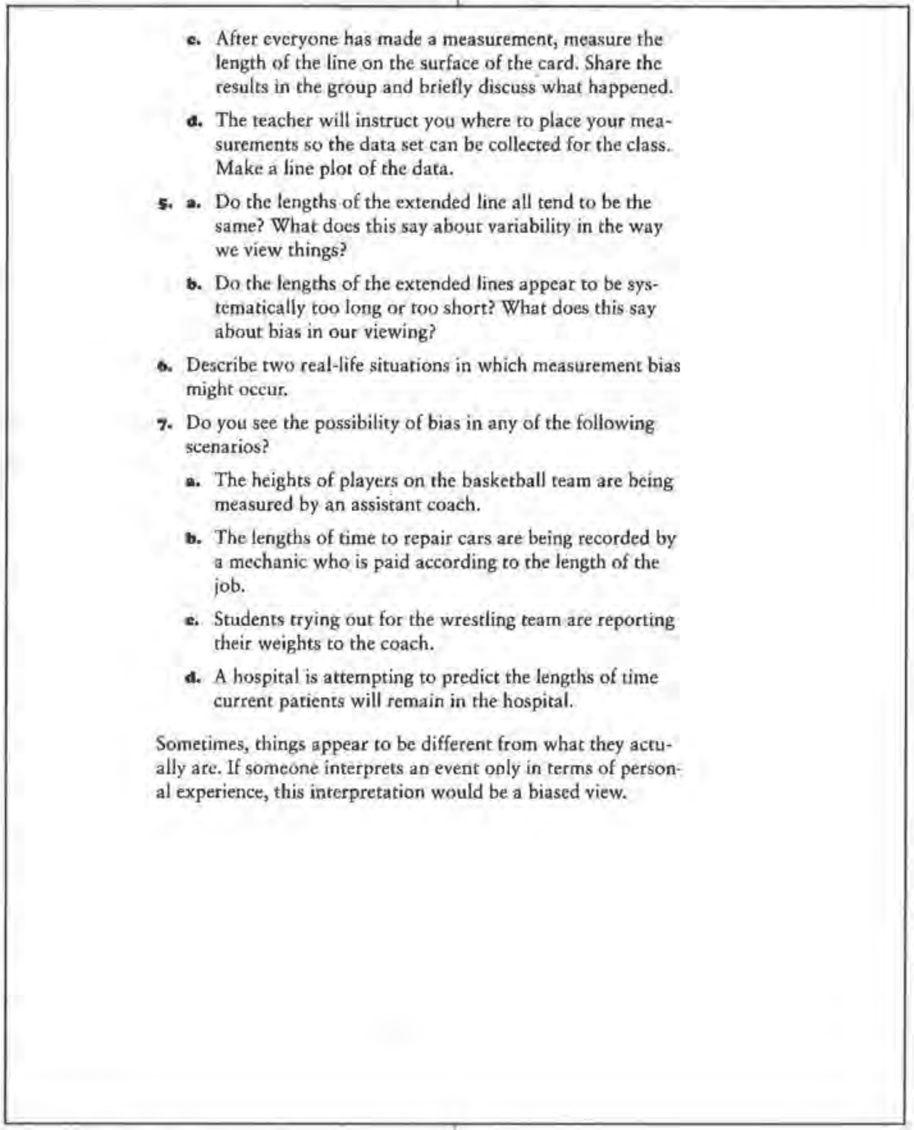
7. **a.** Bias could occur if the coach cannot hold the ruler level above the players' heads. The heights would probably be consistently greater.

b. Bias could occur when recording times. The mechanic probably will round up to the nearest quarter of an hour.

c. Depending upon the weight at which the students want to wrestle, they may overweigh or underweigh themselves. These weights could be biased. Some may weigh themselves with clothes on, wearing heavy shoes, or with keys in their pockets if they want to weigh more. If they want to weigh less, they may weigh themselves with a minimal amount of clothing and not eat much prior to weighing themselves.

d. Bias could occur when recording the length of time spent in the hospital. It is doubtful hospitals calculate to the nearest half hour. Even if this were so, estimating half hours for many patients could add up to a great deal of extra time.

STUDENT PAGE 62



c. After everyone has made a measurement, measure the length of the line on the surface of the card. Share the results in the group and briefly discuss what happened.

d. The teacher will instruct you where to place your measurements so the data set can be collected for the class. Make a line plot of the data.

5. **a.** Do the lengths of the extended line all tend to be the same? What does this say about variability in the way we view things?

b. Do the lengths of the extended lines appear to be systematically too long or too short? What does this say about bias in our viewing?

6. Describe two real-life situations in which measurement bias might occur.

7. Do you see the possibility of bias in any of the following scenarios?

a. The heights of players on the basketball team are being measured by an assistant coach.

b. The lengths of time to repair cars are being recorded by a mechanic who is paid according to the length of the job.

c. Students trying out for the wrestling team are reporting their weights to the coach.

d. A hospital is attempting to predict the lengths of time current patients will remain in the hospital.

Sometimes, things appear to be different from what they actually are. If someone interprets an event only in terms of personal experience, this interpretation would be a biased view.

LESSON 13

Experiments in the Real World

Materials: none
Technology: 4-function calculators
Pacing: 1 class period

Overview

In this lesson, students look at a carefully controlled study that may have direct consequences on their lives.

Teaching Notes

Questions 1 through 6 deal with concepts that seventh- and eighth-grade students should know. Questions 7 and 8 are more difficult, and more mathematical knowledge is necessary. The article may be difficult to read, as students may find unfamiliar words, such as *double blind* and *placebo*. It is probably a good idea to read this summary together and discuss what the authors mean.

STUDENT PAGE 63

LESSON 13

Experiments in the Real World

Who conducts experiments?

What do they do with the results?

Experiments in the real world take place all the time. Use your knowledge of experiments and consider what a real-world experiment might be like.

What follows is a summary of the article, *The Physicians' Health Study—Does Aspirin Help Prevent Heart Attacks?*

During the 1980s, approximately 22,000 male physicians over the age of 40 agreed to participate in a long-term health study for which one important question was to determine whether or not aspirin helps to lower the rate of heart attacks, or myocardial infarctions. The treatments for this part of the study were aspirin or a placebo, which looks like aspirin but contains no aspirin.

One group in the study took aspirin, and the other took the placebo. The physicians were randomly assigned to one medication or the other by a randomization device equivalent to the toss of a coin. Neither the medical examiners nor the participants knew to which group the physicians were assigned. This is called a *double blind* experiment. The method of measurement was to observe the physicians carefully for an extended period of time and to document all heart attacks, as well as other problems, that occurred.

The following table shows how the randomization divided the subjects according to exercise and to cigarette smoking.

OBJECTIVES

Appreciate how experiments are conducted.

Recognize how results of an experiment are used in the real world.

Calculate percents and proportions, standard deviation of a sample proportion, and confidence intervals.

Solution Key

Discussion and Practice

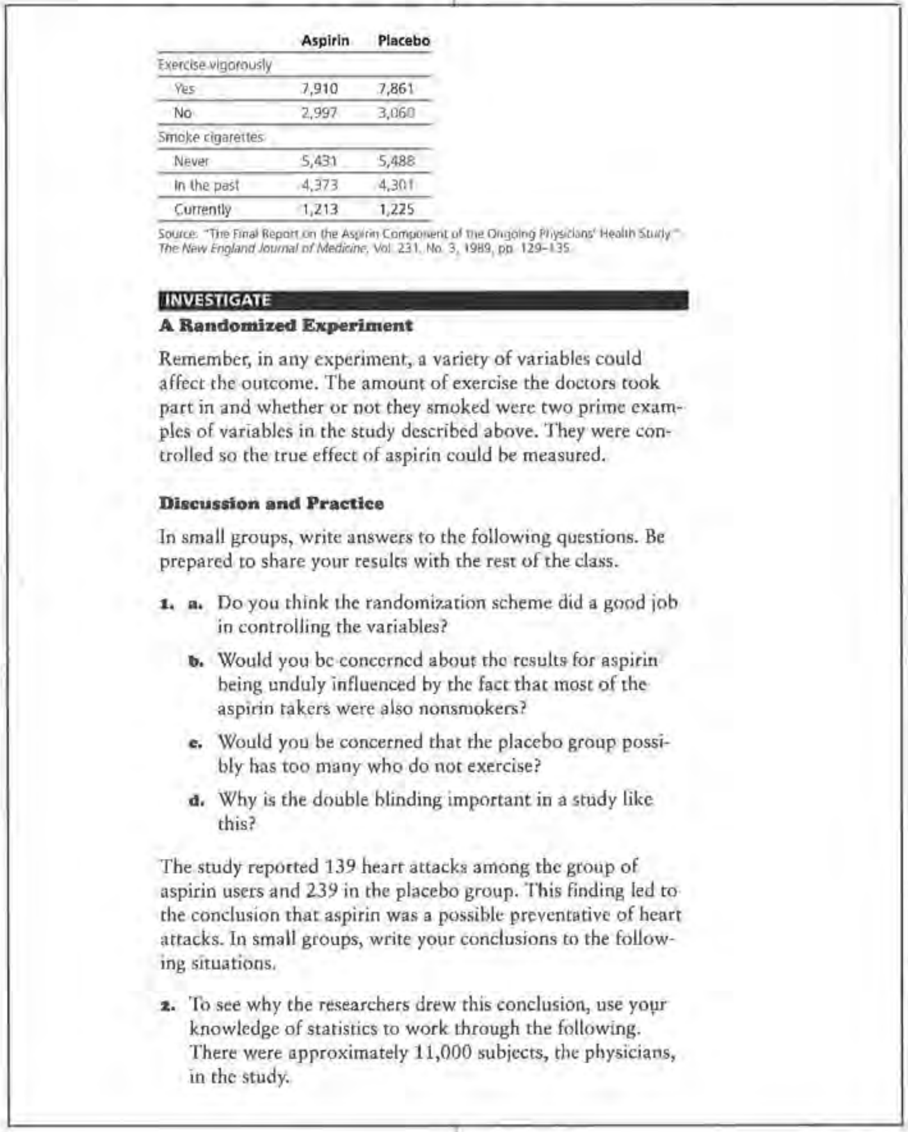
1. **a.** Yes, the balance between aspirin and placebo is good in each group.

   b. No, because the nonsmokers are divided nearly equally between the aspirin and placebo groups.

   c. No, because that number is nearly equal to the number who do not exercise in the aspirin group.

   d. It is important for both the experimenter and for the physicians to be unaware of the type of treatment they are being given. The physicians could obviously be influenced if they knew the treatment. Experimenters could choose to give certain physicians specific treatments, therefore altering the findings of the study.

STUDENT PAGE 64



	Aspirin	Placebo
Exercise vigorously		
Yes	7,910	7,861
No	2,997	3,060
Smoke cigarettes		
Never	5,431	5,488
In the past	4,373	4,301
Currently	1,213	1,225

Source: "The Final Report on the Aspirin Component of the Ongoing Physicians' Health Study." *The New England Journal of Medicine*, Vol. 231, No. 3, 1989, pp. 129–135.

INVESTIGATE

A Randomized Experiment

Remember, in any experiment, a variety of variables could affect the outcome. The amount of exercise the doctors took part in and whether or not they smoked were two prime examples of variables in the study described above. They were controlled so the true effect of aspirin could be measured.

Discussion and Practice

In small groups, write answers to the following questions. Be prepared to share your results with the rest of the class.

1. **a.** Do you think the randomization scheme did a good job in controlling the variables?

   b. Would you be concerned about the results for aspirin being unduly influenced by the fact that most of the aspirin takers were also nonsmokers?

   c. Would you be concerned that the placebo group possibly has too many who do not exercise?

   d. Why is the double blinding important in a study like this?

The study reported 139 heart attacks among the group of aspirin users and 239 in the placebo group. This finding led to the conclusion that aspirin was a possible preventative of heart attacks. In small groups, write your conclusions to the following situations.

2. To see why the researchers drew this conclusion, use your knowledge of statistics to work through the following. There were approximately 11,000 subjects, the physicians, in the study.

2. **a.** $\frac{139}{11{,}000} \approx 0.013$

b. $\frac{239}{11{,}000} \approx 0.022$

3. **a.** The pool of men willing to participate were randomly assigned, essentially by the flip of a coin, to one of the two treatment groups.

b. Yes; if people were arbitrarily placed in groups, you would not necessarily get this balance. Subjective assignments would not have produced the balance on exercise and smoking groups, for example, that is seen here.

4. **a.** A treatment is assigned to an experimental subject: each physician in the study was asked to take a pill. A factor to be controlled is part of the background characteristics: each physician exercised or did not exercise coming into the study; subjects were not told to exercise. The treatment was taking the pill. It was the behavior change.

b. In this experiment, exercise was a factor to be controlled. (See part a.) It was balanced between the treatment groups by the randomization.

5. No; the participants were a highly select group, not a random sample of all males in the population. The goal was not to estimate a population characteristic.

Practice and Applications

6. Answers will vary.

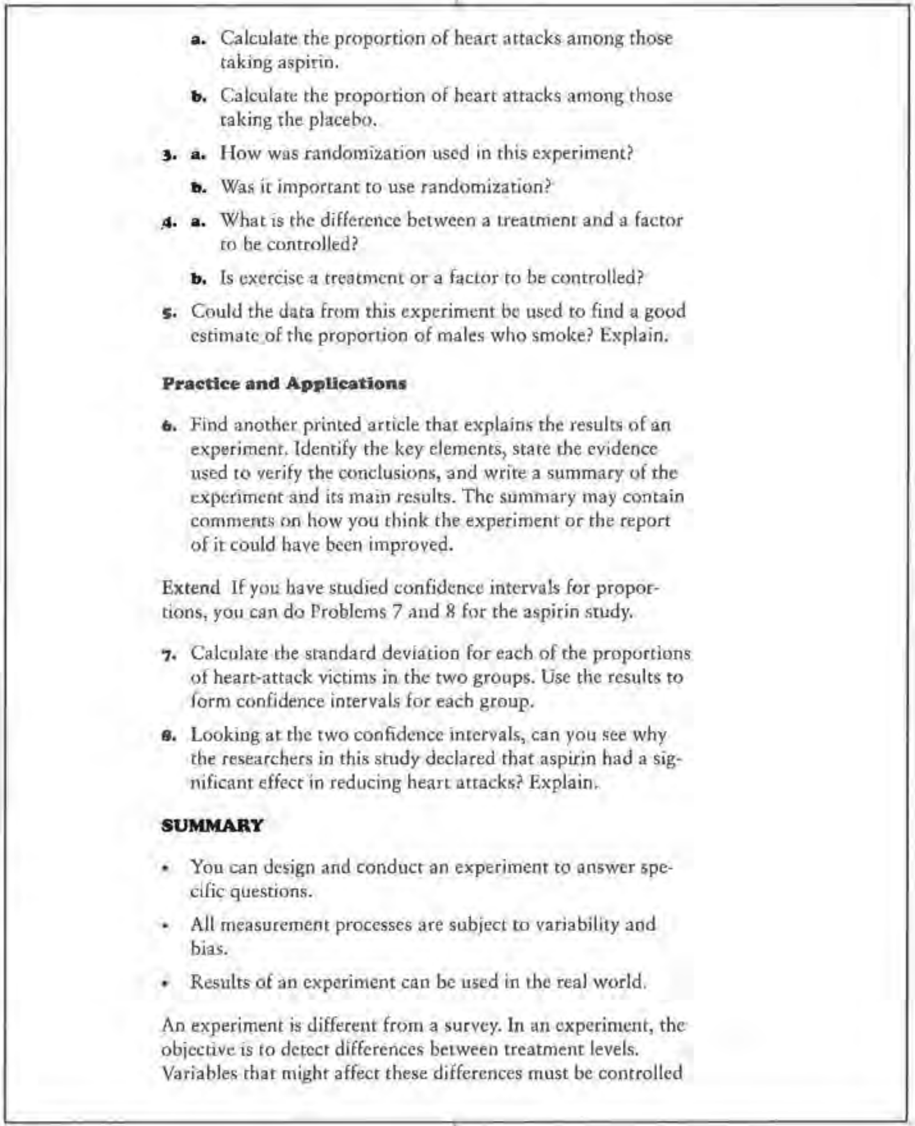
Extend

7. Standard deviation for the aspirin group:

$$2\sqrt{\frac{(0.013)\,(0.987)}{11{,}000}} \approx 0.002$$

0.013 ± 0.002 .or (0.011, 0 .015)

STUDENT PAGE 65



a. Calculate the proportion of heart attacks among those taking aspirin.

b. Calculate the proportion of heart attacks among those taking the placebo.

3. **a.** How was randomization used in this experiment?

b. Was it important to use randomization?

4. **a.** What is the difference between a treatment and a factor to be controlled?

b. Is exercise a treatment or a factor to be controlled?

5. Could the data from this experiment be used to find a good estimate of the proportion of males who smoke? Explain.

Practice and Applications

6. Find another printed article that explains the results of an experiment. Identify the key elements, state the evidence used to verify the conclusions, and write a summary of the experiment and its main results. The summary may contain comments on how you think the experiment or the report of it could have been improved.

Extend If you have studied confidence intervals for proportions, you can do Problems 7 and 8 for the aspirin study.

7. Calculate the standard deviation for each of the proportions of heart-attack victims in the two groups. Use the results to form confidence intervals for each group.

8. Looking at the two confidence intervals, can you see why the researchers in this study declared that aspirin had a significant effect in reducing heart attacks? Explain.

SUMMARY

- You can design and conduct an experiment to answer specific questions.
- All measurement processes are subject to variability and bias.
- Results of an experiment can be used in the real world.

An experiment is different from a survey. In an experiment, the objective is to detect differences between treatment levels. Variables that might affect these differences must be controlled

Standard deviation for the placebo group:

$$2\sqrt{\frac{(0.022)\,(0.978)}{11{,}000}} \approx 0.003$$

0.022 ± 0.003 or (0.019, 0.025)

8. The two-interval estimates of proportions of heart attacks are not close to each other. There is no overlap. It looks as if the placebo group has a significantly higher rate.

STUDENT PAGE 66

or balanced by randomization in the design of an experiment. A good experiment utilizes the following steps:

- Clearly define the question to be investigated and the response to be measured.
- Identify the key variables to be investigated.
- Identify other important variables that can be controlled directly.
- Identify important background variables that cannot be controlled directly but that should be balanced by randomization.
- Randomly assign treatments to the experimental units.
- Decide on a method of measurement that will minimize measurement bias.

UNIT III ACTIVITY

Conducting Your Own Experiment

Materials: rulers and yardstick or meter stick for each group; graph paper
Technology: 4-function calculators
Pacing: 1 class period or more (first experiment)

Overview

These experiments are much more open-ended than experiments in previous lessons. The highlights or the processes of the experiments are given, but students need to make many decisions: exactly what question is asked, how to standardize measurements throughout the group, and how to evaluate the data gathered. The first experiment is outlined in detail. Suggestions for other experiments students can conduct are provided at the end of the lesson.

Teaching Notes

This activity offers a quick way to help students through the process of conducting an experiment. It is structured, but it also allows students to make decisions. They need to consider these questions:

- Which end of the ruler will be toward their hands and which end will be up?
- What measure will they use to measure? Centimeters generally work well, but this can vary depending upon what you want students to learn.
- How high above the hand should they hold the ruler?
- Are they measuring dominant versus nondominant hand; are they measuring boys versus girls? What exactly are they trying to find out?
- How many trials should each person have?
- Once they've gathered the data, what should they do with them?
- Do the data tell them something? Can they generalize or make predictions from what they discovered?
- What happens if they don't catch the ruler?

Students should carefully identify the variables and think about how to design an experiment to answer their questions for any of the other situations. You might have everyone in class do the same experiment or divide those suggested among class groups. Students may offer some alternative ideas for experiments. A science teacher may be very helpful in providing ideas, equipment, and suggestions for scoring.

Other scoring help can be found in the Assessment section on page 121.

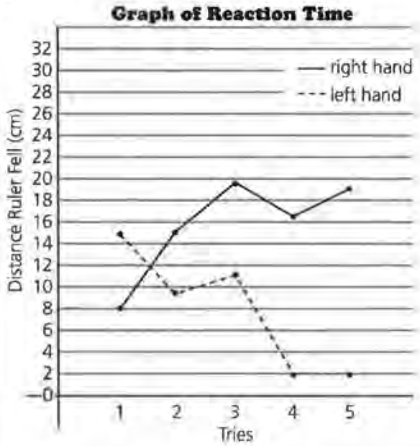
Solution Key

For all problems, answers will vary depending on decisions made by the group. Below are listed the data of one student, Katie, from Brown Middle School in Ravenna, Ohio. Katie is right-handed. The measurements are in centimeters.

Right Hand: 8, 15, 19.5, 16.4, 19
Mean 15.6

Left Hand: 15, 9.5, 10.5, 2, 2
Mean 7.8

This class decided to compare their right hands to their left hands and compare the results. Below is Katie's graph.

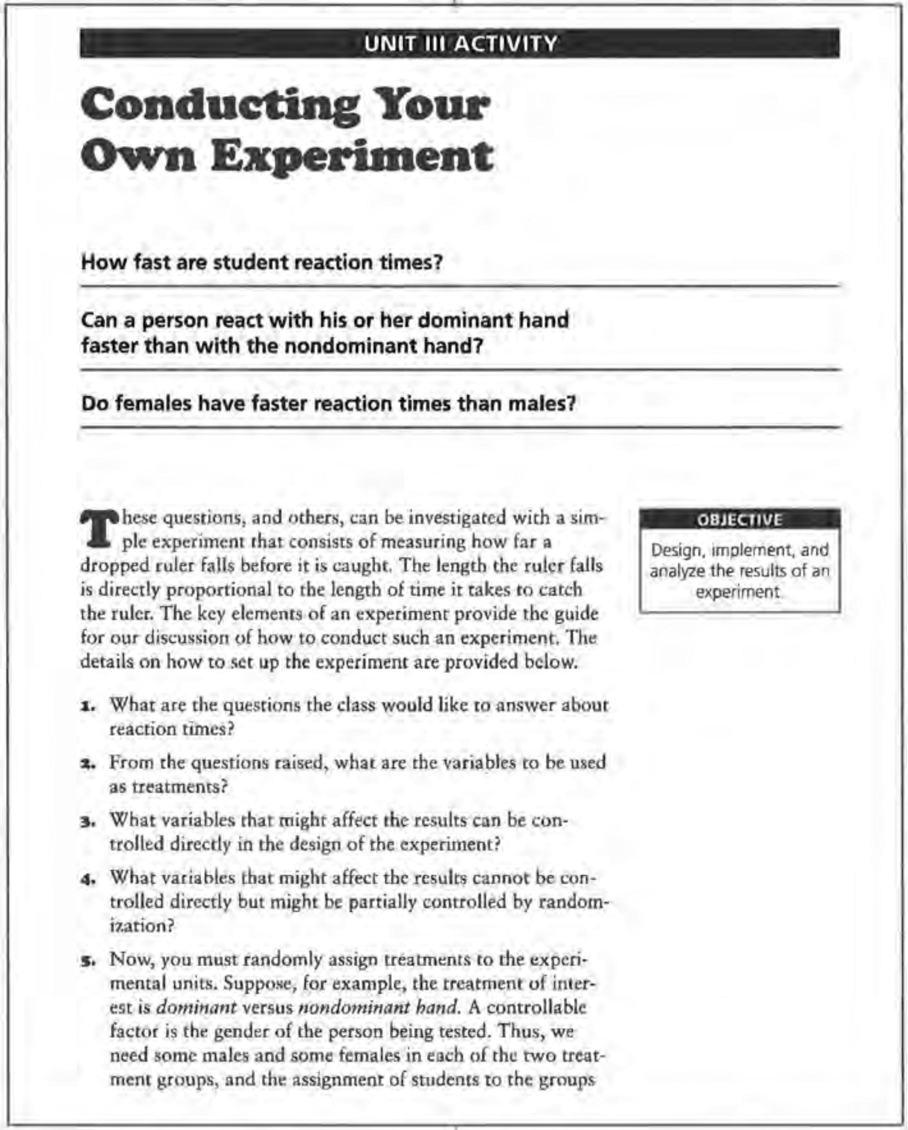


Katie believed the results of this experiment showed that she did better with her nondominant hand than with her dominant hand.

After students recorded their own results, they decided to display the results for boys and girls separately for their dominant hand to determine if there was a difference.

The mean score for the boys was 15.8. The mean score for the girls was 15.5. Of course, the conclusion the girls made was that their reaction time was faster. This conclusion needs to be analyzed. Were enough samples taken?

STUDENT PAGE 67



UNIT III ACTIVITY

Conducting Your Own Experiment

How fast are student reaction times?

Can a person react with his or her dominant hand faster than with the nondominant hand?

Do females have faster reaction times than males?

OBJECTIVE

Design, implement, and analyze the results of an experiment.

These questions, and others, can be investigated with a simple experiment that consists of measuring how far a dropped ruler falls before it is caught. The length the ruler falls is directly proportional to the length of time it takes to catch the ruler. The key elements of an experiment provide the guide for our discussion of how to conduct such an experiment. The details on how to set up the experiment are provided below.

1. What are the questions the class would like to answer about reaction times?
2. From the questions raised, what are the variables to be used as treatments?
3. What variables that might affect the results can be controlled directly in the design of the experiment?
4. What variables that might affect the results cannot be controlled directly but might be partially controlled by randomization?
5. Now, you must randomly assign treatments to the experimental units. Suppose, for example, the treatment of interest is *dominant* versus *nondominant hand.* A controllable factor is the gender of the person being tested. Thus, we need some males and some females in each of the two treatment groups, and the assignment of students to the groups

Were enough students in the experiment? Would the results be the same if the experiment were done again? These are important concepts for the students to discuss.

STUDENT PAGE 68

should be random. How might this be done? NOTE: It is convenient, but not necessary, to have the same number of subjects in each treatment-gender combination.

6. What method of measurement will minimize bias and allow for fair comparisons among the treatment groups? The ruler should be above the opening between the thumb and forefinger of the subject being tested, and then dropped without warning the subject. The subject then catches the ruler as quickly as possible, and the distance the ruler drops is recorded. Should practice runs be allowed? Should other distractions be used to make sure the subject does not know when the ruler will fall? What other issues should be considered in trying to get a fair measurement of reaction time for all the subjects being tested?
7. The data management should be organized so data is correctly recorded on a chart. Should the subjects being tested record their own data?
8. Analyze the data recorded from the experiment. What graphical and numerical summaries provide the best descriptions of interesting features of the data?
9. What conclusions did your group reach in light of the original question(s)? Prepare a presentation to share these conclusions with the remainder of the class.
10. If your group were to design a follow-up study on the issue of student reaction times, what question might you investigate? How would you change the design of the experiment?

Now try your hand at one of the seven experiments described below. Remember experiments are best if they allow a fair amount of data to be collected. If you need help working through your experiment, refer to Unit 4 of this module.

FLY RIGHT

Materials: at least three sheets of paper

Description: Make three airplanes using different designs. Which is the best airplane design? It may depend on what is meant by "best." Work in groups to define at least two different outcome measures of flight performance, such as length of time in the air and accuracy at hitting a target. Then, decide on acceptable ways to measure these outcomes in an experimental situation. Each design/paper combination should be tested at least three times on each of the two outcome measures of

STUDENT PAGE 69

quality. How can bias in the measurement process be reduced? Where should randomization be used?

HOPPING ALONG

Materials: a stopwatch or watch with a second hand

Description: What is your hopping rate? Do you hop faster on your dominant foot? What physical attributes make us fast hoppers? This experiment is to be designed to answer these questions. Work in teams of two. One hops along the marked distance, about 20 meters, and is timed by the other; the return hop is on the other foot. Then, the roles are reversed; the original hopper times while the timer hops. The whole process should be repeated so you have two measures of time on each foot for each person. The times along a specified distance may be turned into rates for further analysis.

Brainstorm and agree on another factor, such as a physical attribute, that could affect hopping speed. Then, analyze the data to see if the foot used, dominant or nondominant, makes any difference or if the other physical attribute, such as height perhaps, makes any difference in hopping rates. Where does randomization come into the design of this experiment?

POPPING OUT

Materials: two popcorn poppers, one a hot-air and one of another type, such as an oil popper; two different brands of popcorn

Description: I am about to purchase a new popcorn popper. Should I buy a hot-air popper or some other type? Get some data on which to base a decision. Try equal amounts of popcorn in each popper and see what happens. Before doing the popping, however, decide upon a meaningful outcome to measure quality. Are you looking for high volume of popped corn, low number of unpopped kernels, or some other measure of popcorn quality? Make sure each brand is tested in each popper. Set up a data recording sheet, collect the data, and analyze them. Write a report of your findings, including a recommendation on which popper to purchase.

BOAT FLOAT

Materials: two equal sized pieces of aluminum foil; two trays of water; salt; a bag of beans

STUDENT PAGE 70

Description: Do things actually float better in salt water? Does the surface area between a boat and the water or the shape of the boat make a difference in the boat's ability to float? To help answer these questions, design two different boats to be constructed out of the sheets of aluminum foil. Each will be floated on both fresh and salt water. The salt water should contain a large dose of salt, so that there is a definite difference in the water types. The measure of floating ability is the number of beans the boat can carry before it sinks. Before carrying out this experiment, think carefully about how to order the steps in the data collection process and how to reduce bias.

HOT STUFF

Materials: two disposable hot cups, one plastic foam and one paper; hot water; two thermometers

Description: Which cup is the better insulator? An experiment will help you find the answer. Heat water to boiling and place equal amounts in a plastic foam cup and a paper cup. Quickly place a thermometer into each cup; the thermometers should have nearly equal readings at the outset. Now, how should insulation effectiveness be measured? Is it the amount by which the temperature decreases in a certain period of time such as ten minutes, or the time it takes to drop a fixed number of degrees such as 20 degrees, or something else? Agree on an appropriate measure and make sure you have at least five such measurements for each type of cup. How can you start the measurement process at the same water temperature each time? What happens if you do not have the same initial water temperature each time? Analyze your data and write up an answer to the original question.

SEEING NEAR AND FAR

Materials: measuring tape or some other method of measuring longer distances

Description: Place one object at a distance of about 20 meters from a designated spot and a similar object at a distance of about 200 meters from the same spot. Do people with a great deal of outdoor experiences, such as hiking, camping, hunting, and skiing, have a better perception of distance than those without that experience? To shed some light on this question, conduct this experiment. First, you must agree on a definition of "experienced outdoor person." Then, a number of students from each group, experienced and not experienced, should be

STUDENT PAGE 71

asked to judge the distances to the two objects. After collecting their guesses, what could be used as the outcome measure of accuracy? When analyzing the data to answer the question on perception of distance, keep in mind there will be much difference in the responses gathered. Can randomization be used here? Write a brief report on the results of this experiment.

THE GRAVITY OF THE ISSUE

Materials: two pairs of identical objects such as two table-tennis balls or two small wooden blocks; a device to accelerate an object horizontally, such as a rubber band

Description: How does the effect of gravity on an accelerated object compare to its effect on free-falling objects? To check this out, construct a device that will accelerate a small object, such as a table-tennis ball, horizontally at the same time an identical object is dropped. Start both objects at the same time and from the same height, such as from the top of a stepladder. To measure the outcome, you might try timing how long it takes the object to hit the floor, but this is a difficult task, as you must be very quick. As an alternative, just record which object hits the floor first. Collect data on the same pair of objects at least ten times, and try the experiment with at least two types of paired items. What did you discover?

UNIT IV

Projects

LESSON 14

A Reference Guide

Materials: none
Technology: none
Pacing: 1 class period

Overview

Often when students have gathered their data, they either forget the types of graphical displays they can make or they know what they want to make but have forgotten how to make it. This lesson helps students create the displays they wish to make, basically covering three areas:

- types of data the student can gather
- measures of center and spread
- types of graphical displays

The types of data covered are categorical data and measurement data.

Measures of center are the mean and the median. The measures of spread are range, interquartile range, and standard deviation. The types of tables, graphs, and charts that are looked at are stem-and-leaf plots, line plots, box plots, histograms, circle graphs or pie charts, picture graphs, scatter plots, and bar graphs. The student edition gives an example of each type along with some direction for its use and construction. This is a resource guide for students. There are no exercises given. The material can be reviewed as a class, or students can use this section as they need it when they are working on their projects.

STUDENT PAGE 75

LESSON 14

A Reference Guide

What are some graphical representations that can display data in a meaningful way? What are the measures of center? of variability?

How do these two measures help you to understand the data?

OBJECTIVE

Use a reference guide as a tool when working on individual projects.

This section will help refresh your memory about these topics and ideas you have covered:

- types of variables you will be using
- measures of center and spread
- types of graphical displays

Types of Variables

You may recall learning about two types of variables: measurement variables (quantitative) and categorical variables (qualitative).

- Measurement data result when you determine the extent, size, quantity, or capacity of something. An example is your height or weight. You can also use measurement variables to determine how far you can jump, to determine how long you can hold your breath, or to make a guess as to how many candies are in a bag.
- Categorical data tend to be information about classification of objects or people, for example, males or females; left-handed or right-handed people; or brands of shoes students are wearing.

Measures of Center and of Spread

When thinking about the measurements you gather in your project, you may want to consider using tools that help you

STUDENT PAGE 76

think about the center of your data and the variables in your data. This may help you analyze the information you have gathered. Measures commonly used are

Center

- *mean*
- *median*

Variability

- *range*
- *interquartile range*
- *standard deviation*

Types of Graphical Displays

The type of data you collect and the questions you are trying to answer should help you to determine the types of tables, graphs, and charts you will use to display your data.

When using *measurement data,* you may want to consider making

- *stem-and-leaf plots*
- *line plots*
- *box plots*
- *histograms*
- *picture graphs*
- *scatter plots*

When using categorical data, you may want to consider making

- *bar graphs*
- *circle graphs*
- *picture graphs*

The following example shows the measures of center and spread and the types of graphs and plots you can use. Today many people are very health-conscious. People are watching calories and fat grams. The Mars® candy company has been watching this trend and has created a new low-calorie, low-fat bar called Milky Way II®.

STUDENT PAGE 77

The following table compares calories and fat content of the top-selling candy bars. It also tells us the new Milky Way II bar has 190 calories and 8 grams of fat.

A Candy Comparison

Here's how the top-selling chocolate candies compare to the new Milky Way II, which has 190 calories and 8 grams of fat.

	Calories	Fat
1. M&M's® (plain)	230	10 g
M&Ms® (peanut)	250	13 g
2. Snickers®	280	13 g
3. Reese's® Peanut Butter Cup™	250	15 g
4. Hershey's® Kisses (six)	150	9 g
5. Milky Way®	280	11 g
6. Hershey's® Milk Chocolate (plain)	240	14 g
Hershey's® Milk Chocolate (almonds)	230	14 g
7. Kit Kat®	230	12 g
8. Twix®	280	7 g
9. Three Musketeers®	260	9 g
10. (tie) Nestlé® Crunch™	210	10 g
Nestlé® Butterfinger™	280	11 g

Source: data from *USA TODAY*, 1993

First examine the measures of center and spread of the fat content of the data.

- The mean amount of fat in these 13 candy bars is 11.385. We added the 13 numbers in the fat column and then divided the sum by 13.
- The median amount of fat is 11. This means the number of candy bars with a fat content *greater than* 11 is the same as those with a fat content *less than* 11.
- The range is 8. This is the difference between the greatest amount of fat, 15, and the least amount of fat, 7.

When comparing these measures to the new Milky Way II bar, you see that the amount of fat in the new bar is far less than either the mean or the median of the top-selling candy bars. The variability in the number of calories and grams of fat is really not useful information to help you to decide if you would like to try the new bar. Consider how a plot can help you understand the distribution of fat in candy bars.

STUDENT PAGE 78

Stem-and-Leaf Plot

Fat Content in Top-Selling Candy Bars

0 | 7 9 9
1 | 0 0 1 1 2 3 3 4 4
1 | 5

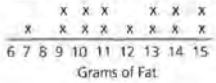
Key: 1 | 5 means 15 grams of fat

This stem-and-leaf plot shows that the range of fat content in top-selling candy bars is from 7 to 15 grams with the majority of the bars containing between 10 and 14 grams.

This display gives us some information about the fat content in candy bars. However, a stem-and-leaf plot is more helpful when the minimum number of data points is 25.

Line Plot

Fat Content in Top-Selling Candy Bars

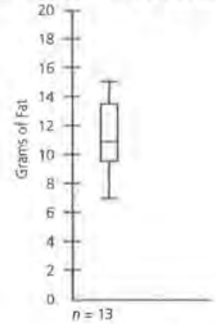


The mean is 11.385. This line plot generally shows that there is variability in the fat content of top-selling candy bars. The standard deviation is 2.3. Since the Milky Way II bar has 8 grams of fat, you can see from the plot that only one bar has less fat.

STUDENT PAGE 79

Box Plot

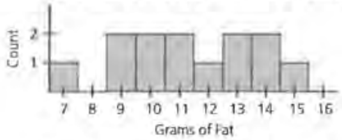
Fat Content in Top-Selling Candy Bars



This box plot indicates that the interquartile range is 4 grams. Therefore, 50% of the top-selling candy bars contain between 9.5 (lower quartile) and 13.5 (upper quartile) grams of fat. It shows the range of fat content is between 7 and 15. The median amount of fat is 11 grams. Furthermore, if you placed the Milky Way II bar on this plot, it would be in the lowest 25% of fat content among the top-selling candy bars.

Histogram

Fat Content of Top-Selling Candy Bars



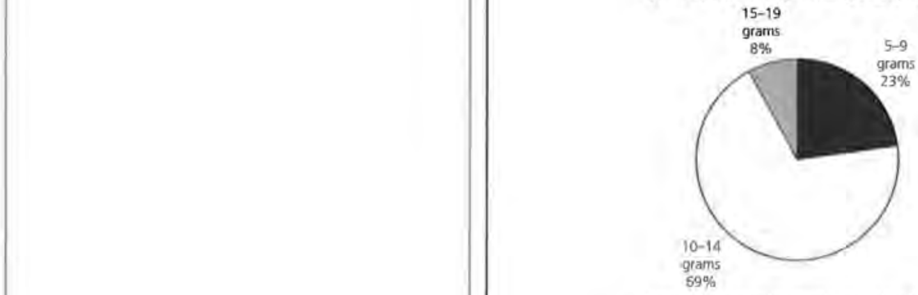
The histogram generally shows that while there is variability in the fat content in the bars, the frequency is relatively stable. In other words, the least number of candy bars that has any one amount of fat is one and the greatest is two.

The following three graphical representations show how measurement data can be displayed in categorical formats if you use grouping.

STUDENT PAGE 80

Circle Graph, or Pie Chart

Fat Content in Top-Selling Candy Bars

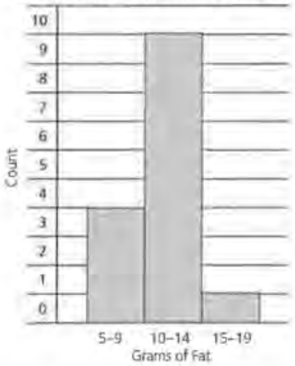


To make a circle graph, or pie chart, with these data, the data points needed to be grouped into categories. The three categories used were 5–9 grams; 10–14 grams; and 15–19 grams. This grouping can also be used in developing a histogram or a picture graph.

To make a circle graph, you must divide the number of data points in that category by the total. For example, three data points fell between 5 and 9 grams of fat. Three was divided by 13, the total, for 0.23 or 23%. This decimal was multiplied by 360, the number of degrees in a circle, to get the number of degrees for that category. In this case, it was 83°.

Histogram Using Grouping

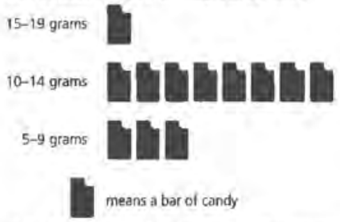
Fat Content in Top-Selling Candy Bars



STUDENT PAGE 81

Picture Graph

Fat Content in Top-Selling Candy Bars



All of these graphs show that the greatest number of candy bars have between 10 grams and 14 grams of fat. The new Milky Way II has less fat than the majority of the bars.

Since the measurement data were divided into categories, categorical data can also be used to make circle graphs, pie charts, histograms, or picture graphs.

Scatter Plots

Scatter plots are used to determine if there is any relationship between paired measurements. The table below and on the next page shows the cigarette consumption per adult per year and the number of deaths per 100,000 people per year due to coronary heart disease in 21 countries. The plot that follows the table shows that there seems to be a strong association among the variables.

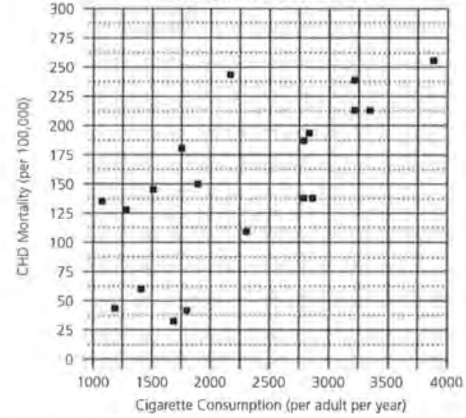
Country	Cigarette Consumption per Adult per Year	CHD Mortality per 100,000 (ages 35–64)
United States	3,900	257
Canada	3,350	212
Australia	3,220	238
New Zealand	3,220	212
United Kingdom	2,790	194
Switzerland	2,780	125
Ireland	2,770	187
Iceland	2,290	111
Finland	2,160	233
West Germany	1,890	150
Netherlands	2,820	125
Greece	1,800	41
Austria	1,770	182
Belgium	1,700	118

STUDENT PAGE 82

Mexico	1,680	32
Italy	1,510	114
Denmark	1,500	145
France	1,410	60
Sweden	1,270	127
Spain	1,200	44
Norway	1,090	136

Source: *Exploring Data* by James M. Landwehr and Ann E. Watkins, 1986

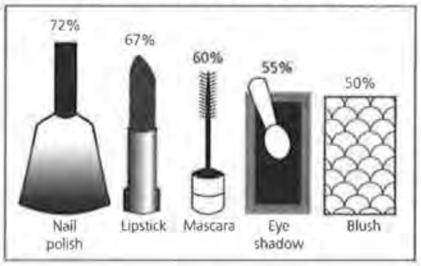
Example of a Scatter Plot



Bar Graph

Here is an example of a bar graph with unusual pictorial bars.

Cosmetics Used by Teenage Girls



Source: data from *USA TODAY*, July 7, 1994

STUDENT PAGE 83

Notice a few things about this graph. There are no "raw" data given—only percents. Also, no details are given about how the information was gathered. You might also notice that the traditional bars are replaced by pictures of the objects described. It does show you that nail polish is the most common type of makeup used by teenage girls, with lipstick following a close second. Blush is the least common type of makeup used by teenage girls.

SUMMARY

This summary of types of variables, measures of center and spread, and types of graphs and plots can be helpful to you both before you begin to gather data and when you are ready to display and analyze the data. Some things to remember are:

- Pie charts, picture graphs, and bar graphs are best used for describing categorical data. Remember this when you design your project. If you want more variety, you may want to consider some data that produce a measurement result. Line plots, stem-and-leaf plots, box plots, and histograms are most useful for measurement data.
- All graphs must have a title explaining the general topic of the graph.
- If graphs have axes, they must be labeled as to what each axis represents.
- There should be an explanation for each graph following the display.
- How a graph looks is very important. Remember to use a ruler. Color can also enhance both the appearance and the comprehensibility of your graph.

LESSON 15

Doing a Project

Materials: 4-by-6-inch cards; paper clips, rubber bands, or large envelopes (optional), art materials for graphs and cover sheets; *Activity Sheets 6–10* (Materials other than those listed here may be needed according to the projects chosen.)
Technology: computers and statistical software (optional)
Pacing: 1 week to entire semester, depending upon projects selected

Overview

An important part of this module is having students actually do a project. The process has been broken down into ten separate steps with specific assignments following many of the steps.

Teaching Notes

The solutions here will give a brief description of what to look for when the students turn in their work or ask questions about their work. It is divided into the ten steps students follow for doing a project.

Students often have difficulty starting their projects and getting organized. Two different project requirement sheets, *Activity Sheets* 6 and 7, are provided to help them and to give you a structure to use for assessing student work. *Activity Sheet* 6 is more directed and may be more effective with younger students.

In Problem 6, students are asked to turn in a progress report. You should have students put all their work to that point in large envelopes, or secure their work with paper clips or rubber bands, so you can review their progress. Quickly return the materials so students can continue their work. For Problem 7, you may have students write a statistical summary of their data. Be sure students use the evidence they have gathered to make their conclusions. Graphs, statistical summaries, and words placing these in context should be a part of their summary. Students can then include these summaries in their final project write-ups.

If there is a local chapter of the American Statistical Association, they may be able to provide a statistician who would be willing to serve as a consultant for the groups as they work on their projects. Most groups find such input extremely helpful. Information about local chapters is available from:

American Statistical Association
1429 Duke Street
Alexandria, VA 22314-3415
(703) 684-1221

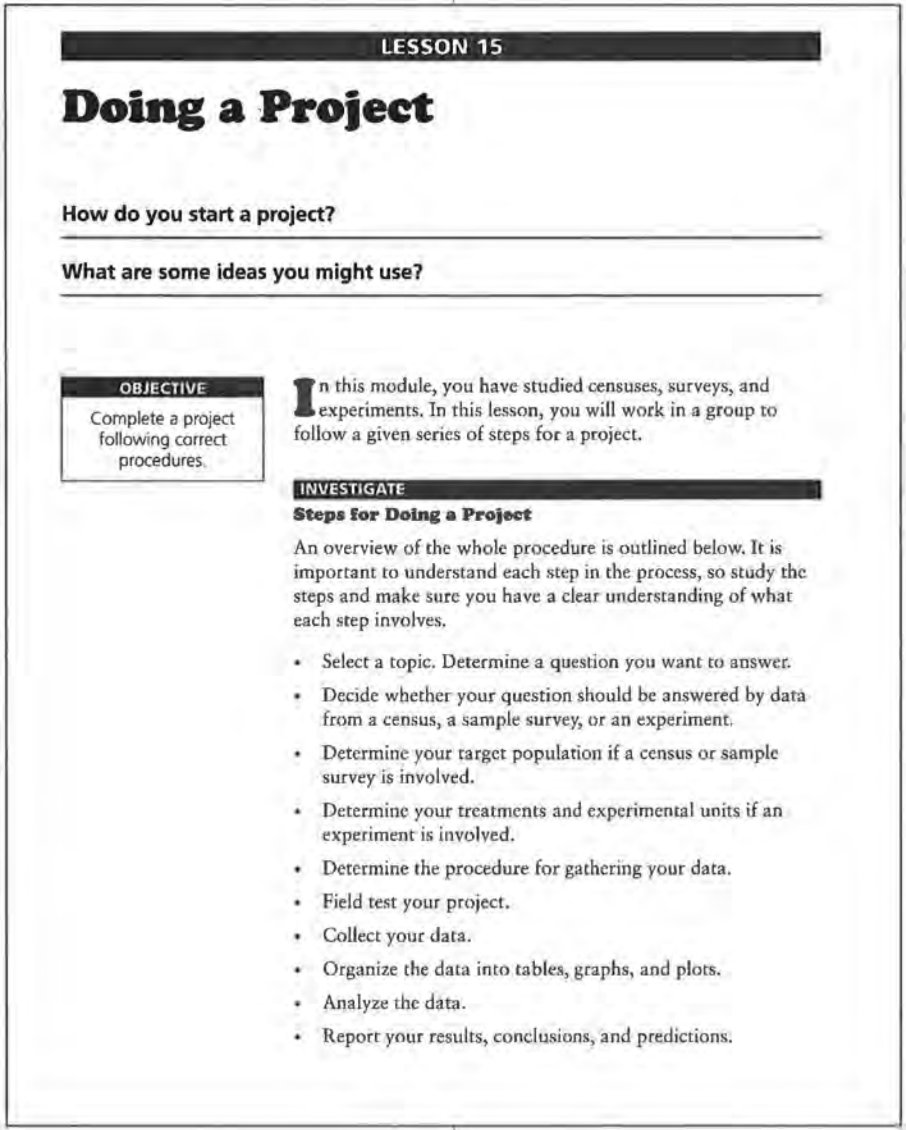
After students complete their projects, you should decide how best to evaluate them. This module offers several options. Each of these evaluating methods is described in detail in the *Assessment Ideas* section on pages 121–124.

- Peer evaluations (see page 122)
- Portfolios (see page 122)
- Rubrics (see page 123)
- Holistic grading with comments (see page 124)
- Grading by points (see page 124)

Technology

The amount of technology needed depends upon the projects the students choose. A computer with statistical software would be useful. Some easy to use statistical software packages are *Data Insights*™ (for Apple II and IBM) and *Statistics Workshop*™ (for Macintosh). Both are from Sunburst® Productions, Inc. and are very student-friendly. Many other software packages are available. Students should be encouraged to use a word processor to write up their results.

STUDENT PAGE 84



LESSON 15

Doing a Project

How do you start a project?

What are some ideas you might use?

OBJECTIVE

Complete a project following correct procedures.

In this module, you have studied censuses, surveys, and experiments. In this lesson, you will work in a group to follow a given series of steps for a project.

INVESTIGATE

Steps for Doing a Project

An overview of the whole procedure is outlined below. It is important to understand each step in the process, so study the steps and make sure you have a clear understanding of what each step involves.

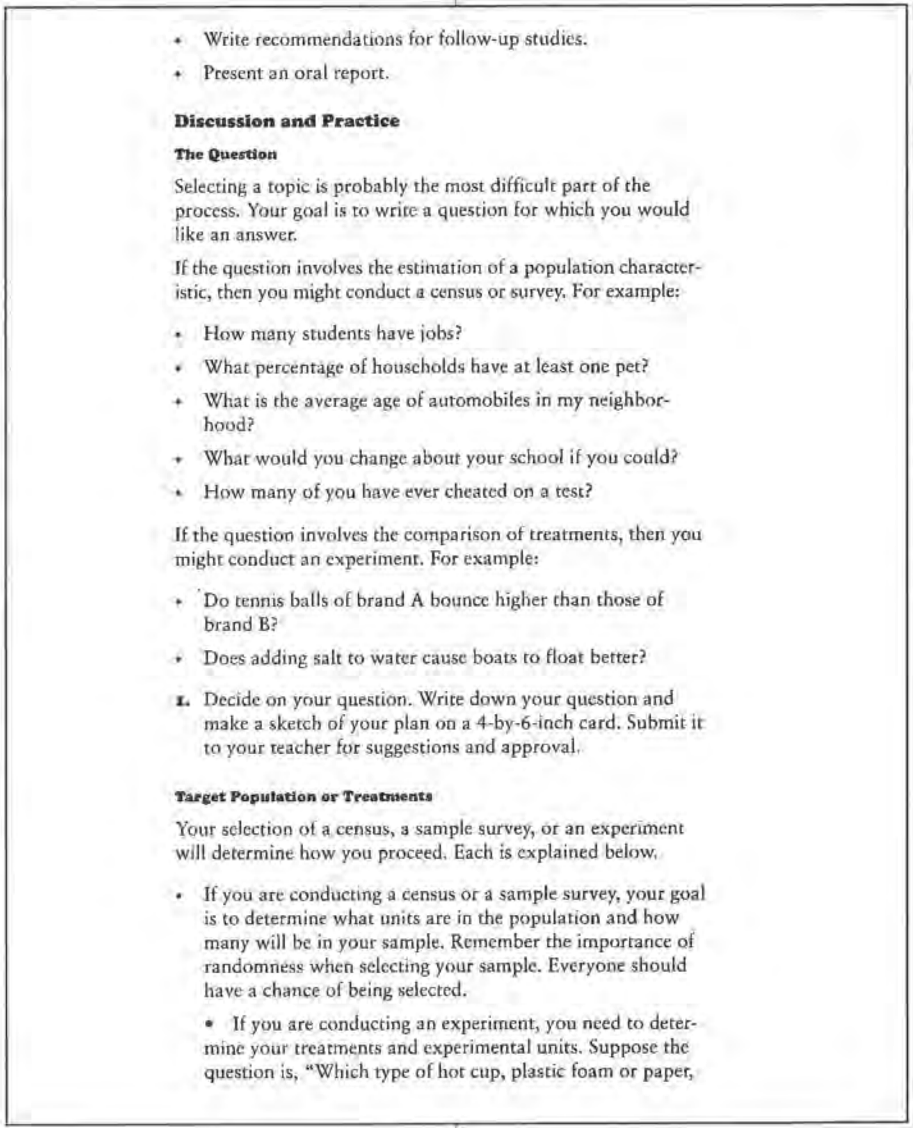
- Select a topic. Determine a question you want to answer.
- Decide whether your question should be answered by data from a census, a sample survey, or an experiment.
- Determine your target population if a census or sample survey is involved.
- Determine your treatments and experimental units if an experiment is involved.
- Determine the procedure for gathering your data.
- Field test your project.
- Collect your data.
- Organize the data into tables, graphs, and plots.
- Analyze the data.
- Report your results, conclusions, and predictions.

Solution Key

Discussion and Practice

1. The Question—When students bring you their project topic on a 4-by-6-inch card, check the following:
- Is the project too broad? Would a part of the project be better?
- Is the task "doable"? Can students gather the data or do the experiment successfully?
- Are there legal or moral questions students need to consider? For example, if surveying in a mall, do students need to contact the security service of the mall before they begin?
- Is the topic redundant; that is, have many students chosen the same topic?
- Be sure to approve all topics before students begin to collect data.

STUDENT PAGE 85



- Write recommendations for follow-up studies.
- Present an oral report.

Discussion and Practice

The Question

Selecting a topic is probably the most difficult part of the process. Your goal is to write a question for which you would like an answer.

If the question involves the estimation of a population characteristic, then you might conduct a census or survey. For example:

- How many students have jobs?
- What percentage of households have at least one pet?
- What is the average age of automobiles in my neighborhood?
- What would you change about your school if you could?
- How many of you have ever cheated on a test?

If the question involves the comparison of treatments, then you might conduct an experiment. For example:

- Do tennis balls of brand A bounce higher than those of brand B?
- Does adding salt to water cause boats to float better?

1. Decide on your question. Write down your question and make a sketch of your plan on a 4-by-6-inch card. Submit it to your teacher for suggestions and approval.

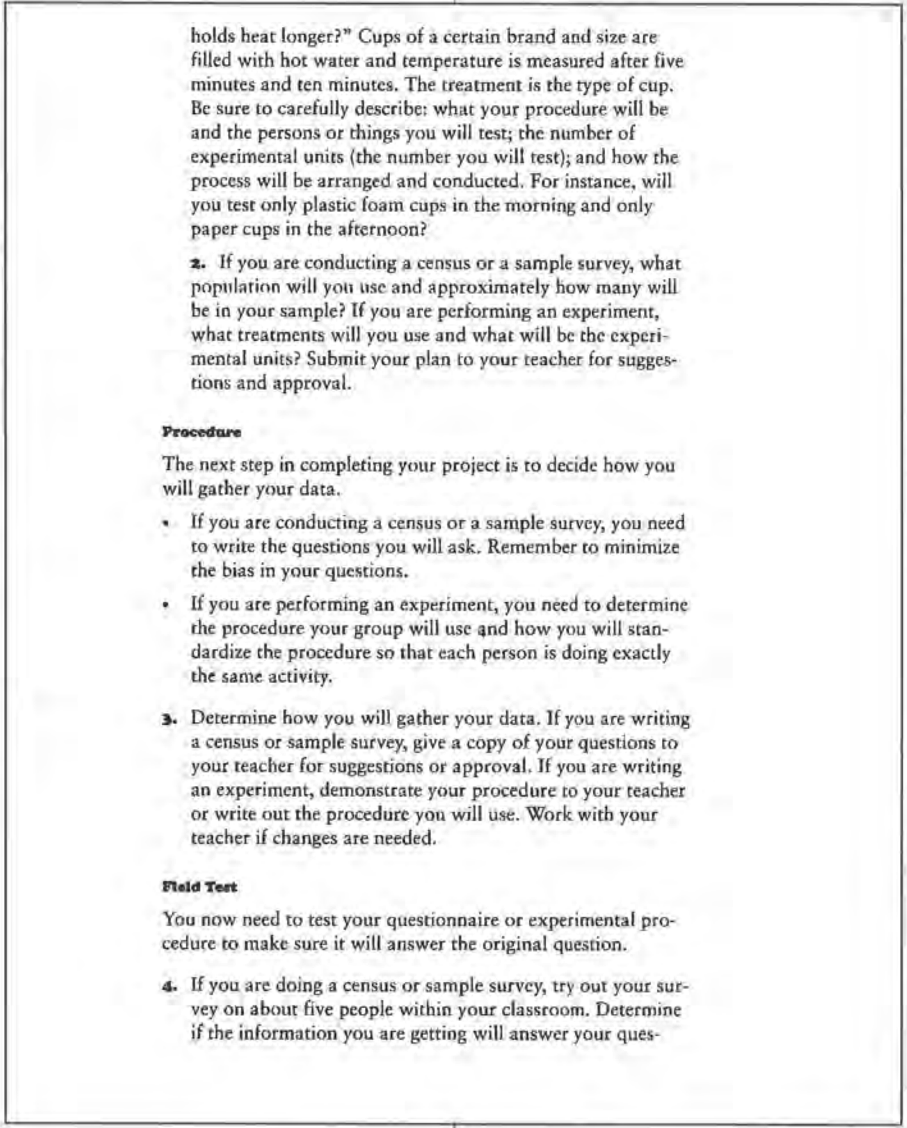
Target Population or Treatments

Your selection of a census, a sample survey, or an experiment will determine how you proceed. Each is explained below.

- If you are conducting a census or a sample survey, your goal is to determine what units are in the population and how many will be in your sample. Remember the importance of randomness when selecting your sample. Everyone should have a chance of being selected.
  - If you are conducting an experiment, you need to determine your treatments and experimental units. Suppose the question is, "Which type of hot cup, plastic foam or paper,

2. The Target Populations or Treatment—After students have decided on their questions, they must then decide whom they will survey or on what they will experiment. Check the following:
   - If students are doing a survey, are they clear on the difference between the population and the sample?
   - If they are doing a survey, have students chosen a random way to select their samples?
   - If they are doing an experiment, do students understand the difference in the treatment group(s) and the control group?
3. The Procedure—Make sure students have considered the following:
   - In a survey, the questions should be free from bias.
   - In an experiment, the procedure should give unbiased measurements of the effect being studied.

STUDENT PAGE 86



holds heat longer?" Cups of a certain brand and size are filled with hot water and temperature is measured after five minutes and ten minutes. The treatment is the type of cup. Be sure to carefully describe: what your procedure will be and the persons or things you will test; the number of experimental units (the number you will test); and how the process will be arranged and conducted. For instance, will you test only plastic foam cups in the morning and only paper cups in the afternoon?

2. If you are conducting a census or a sample survey, what population will you use and approximately how many will be in your sample? If you are performing an experiment, what treatments will you use and what will be the experimental units? Submit your plan to your teacher for suggestions and approval.

Procedure

The next step in completing your project is to decide how you will gather your data.

- If you are conducting a census or a sample survey, you need to write the questions you will ask. Remember to minimize the bias in your questions.
- If you are performing an experiment, you need to determine the procedure your group will use and how you will standardize the procedure so that each person is doing exactly the same activity.

3. Determine how you will gather your data. If you are writing a census or sample survey, give a copy of your questions to your teacher for suggestions or approval. If you are writing an experiment, demonstrate your procedure to your teacher or write out the procedure you will use. Work with your teacher if changes are needed.

Field Test

You now need to test your questionnaire or experimental procedure to make sure it will answer the original question.

4. If you are doing a census or sample survey, try out your survey on about five people within your classroom. Determine if the information you are getting will answer your ques-

STUDENT PAGE 87

> tion. If you are successful, continue to the next part. If you are having difficulty, make revisions and talk to your teacher. If you are doing an experiment, determine if your procedure will provide an answer to your question. If you are successful, continue to the next part. If you are having difficulty, make revisions and talk to your teacher.
>
> **Collect Data**
>
> 5. Now gather the information you need to answer your question. If you are working in a group, be sure all members are aware of their tasks. Make sure each person asks questions in the same way or does the experimental procedure in the same manner.
>
> **Organize**
>
> 6. Organize the data you gathered and display it so the information is easily understood. Lesson 15 of this module contains a summary of some types of graphs you could make. Lesson 16 will help you decide how best to represent data for your project. Prepare and give your teacher a progress report.
>
> **Analyze**
>
> 7. Carefully answer your original question based on the data you collected. Look for any unusual results and try to figure out what might have been the cause. Write a statistical summary of your findings.
>
> **Report**
>
> 8. Write a report of your results. Before starting, read the *Information Sheet, Informing Others* found on page 95. It will help you to write a good report. Follow these guidelines:
>   - Type or neatly write your report on 8.5-by-11-inch paper.
>   - Carefully mount all graphs, charts, and tables.
>   - Illustrate your cover sheet and include the project title, the names of the persons in your group, and the date.

4. Field Test—Students will test their designs. They need to articulate problems they had with their trials and make changes that will make their plans more effective.

5. Collect Data—If the projects are to be done in the classroom or in the school, you can help with the organizational structure of the data collection. This will be dependent upon the structure of your school setting.

6. Organize—The goal is to use graphical displays to help answer the original question. Your help in setting up the graphs may be required. Some quick guidelines are:
    - Label the axes and title the graphs.
    - Make sure graphs are appropriate for the data.
    - Use rulers so work is neatly done.

If students have not already completed Lessons 14 and 16, now would be a good time to complete them.

If students are following the checklist on *Activity Sheet 7,* ask for a progress report from each student or group. Give students the large envelopes and ask them to enclose their data, copies of questionnaires or surveys, graphs they have used, a brief progress report, and a list of references they have used. Review these progress reports quickly to make sure students are on the right track, and return them so students can begin their drafts of their projects.

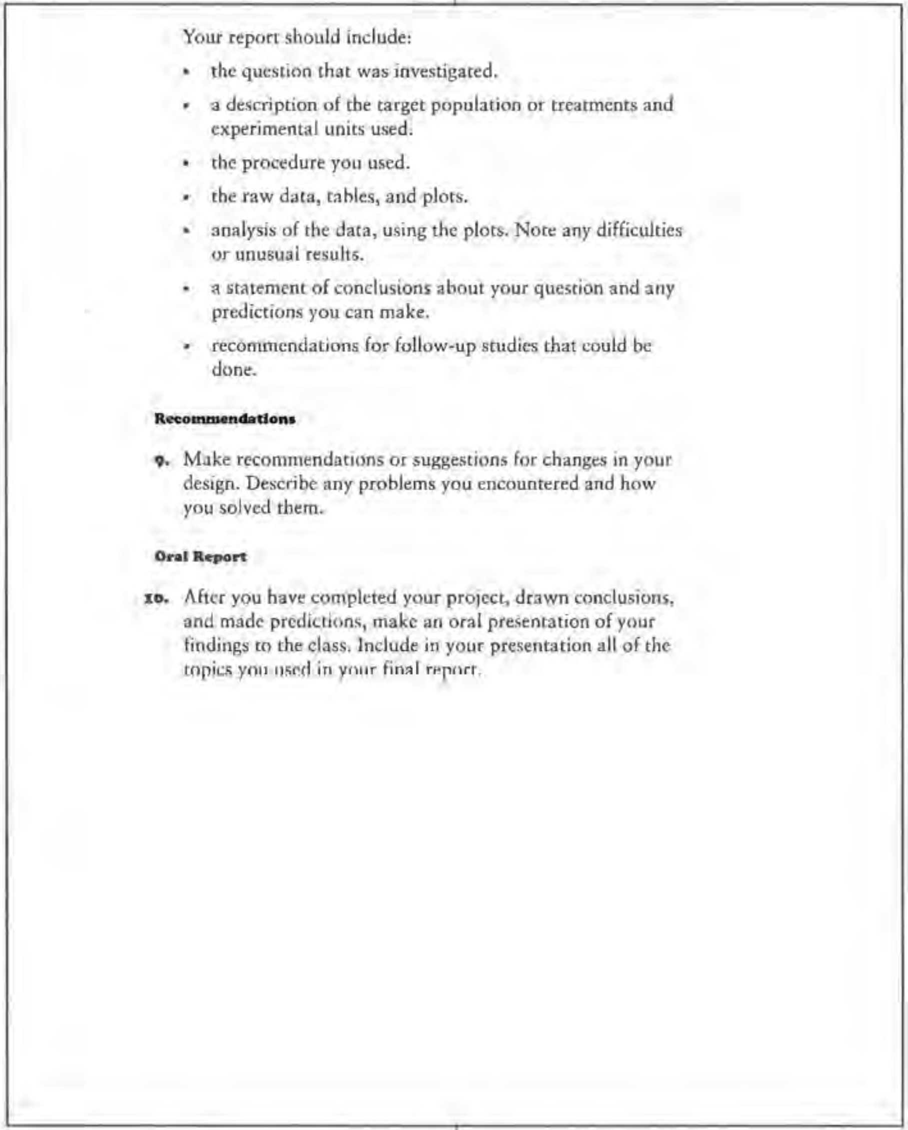
7. Analyze—You need to make sure the conclusions students make are based on the data they gathered. Also, unusual findings need to be addressed.

8. Report—Prior to beginning their reports, students need to be very clear on what is expected in the report. The text states exactly what is required and this should be stressed. Often this analysis is the most difficult part for the student. Conference time with each group is helpful. *Activity Sheet 6* also has clear guidelines for students. Before writing their reports, students should do Lesson 17.

9. Recommendations—Projects do not always run smoothly. Students should not consider these signs of failure, but explain what happened and how they resolved the situation. Frequently, the data do not support the hypothesis students had in mind. This again does not signal failure nor necessarily the need to collect more data. They have to accept the fact their theory was not valid. Once again, students may need assistance in determining what conclusions are appropriate based on the information they gathered. They often want to make recommendations that are not based on fact but rather on perception. This is an important distinction to bring out.

10. Oral Report—This is the chance for students to present their findings to the class or to some other significant group. This is a good time to set up some type of evaluation tool for yourself and for the group to use for each project as it is presented.

STUDENT PAGE 88



Your report should include:

- the question that was investigated.
- a description of the target population or treatments and experimental units used.
- the procedure you used.
- the raw data, tables, and plots.
- analysis of the data, using the plots. Note any difficulties or unusual results.
- a statement of conclusions about your question and any predictions you can make.
- recommendations for follow-up studies that could be done.

Recommendations

9. Make recommendations or suggestions for changes in your design. Describe any problems you encountered and how you solved them.

Oral Report

10. After you have completed your project, drawn conclusions, and made predictions, make an oral presentation of your findings to the class. Include in your presentation all of the topics you used in your final report.

LESSON 16

Representing the Same Data in Different Ways

Materials: none
Technology: 4-function calculators
Pacing: 1 class period or more

Overview

Data can be represented in a variety of ways. Some ways make certain data easier to understand. This lesson takes the same data and shows them in a variety of ways so students understand how the display selected has an effect on the reader.

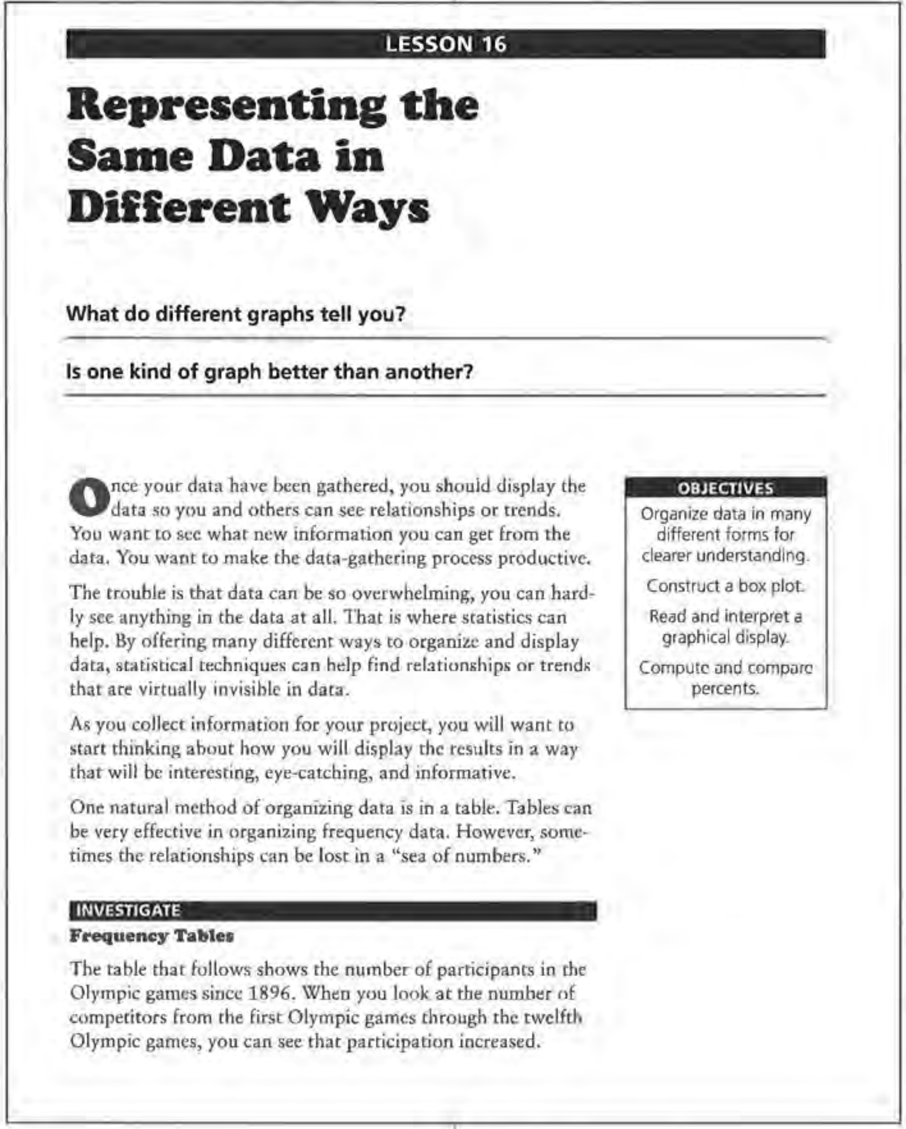
Teaching Notes

It may be necessary to review the purposes and features of the various types of graphs and plots that are commonly used to help readers to understand data and see relationships and trends.

Technology

Spreadsheets and graphing calculators can help students "see" things in the data. If you have access to a computer lab, this activity lends itself well to the use of a spreadsheet or graphing package.

STUDENT PAGE 89



LESSON 16

Representing the Same Data in Different Ways

What do different graphs tell you?

Is one kind of graph better than another?

Once your data have been gathered, you should display the data so you and others can see relationships or trends. You want to see what new information you can get from the data. You want to make the data-gathering process productive.

The trouble is that data can be so overwhelming, you can hardly see anything in the data at all. That is where statistics can help. By offering many different ways to organize and display data, statistical techniques can help find relationships or trends that are virtually invisible in data.

As you collect information for your project, you will want to start thinking about how you will display the results in a way that will be interesting, eye-catching, and informative.

One natural method of organizing data is in a table. Tables can be very effective in organizing frequency data. However, sometimes the relationships can be lost in a "sea of numbers."

OBJECTIVES

Organize data in many different forms for clearer understanding.

Construct a box plot.

Read and interpret a graphical display.

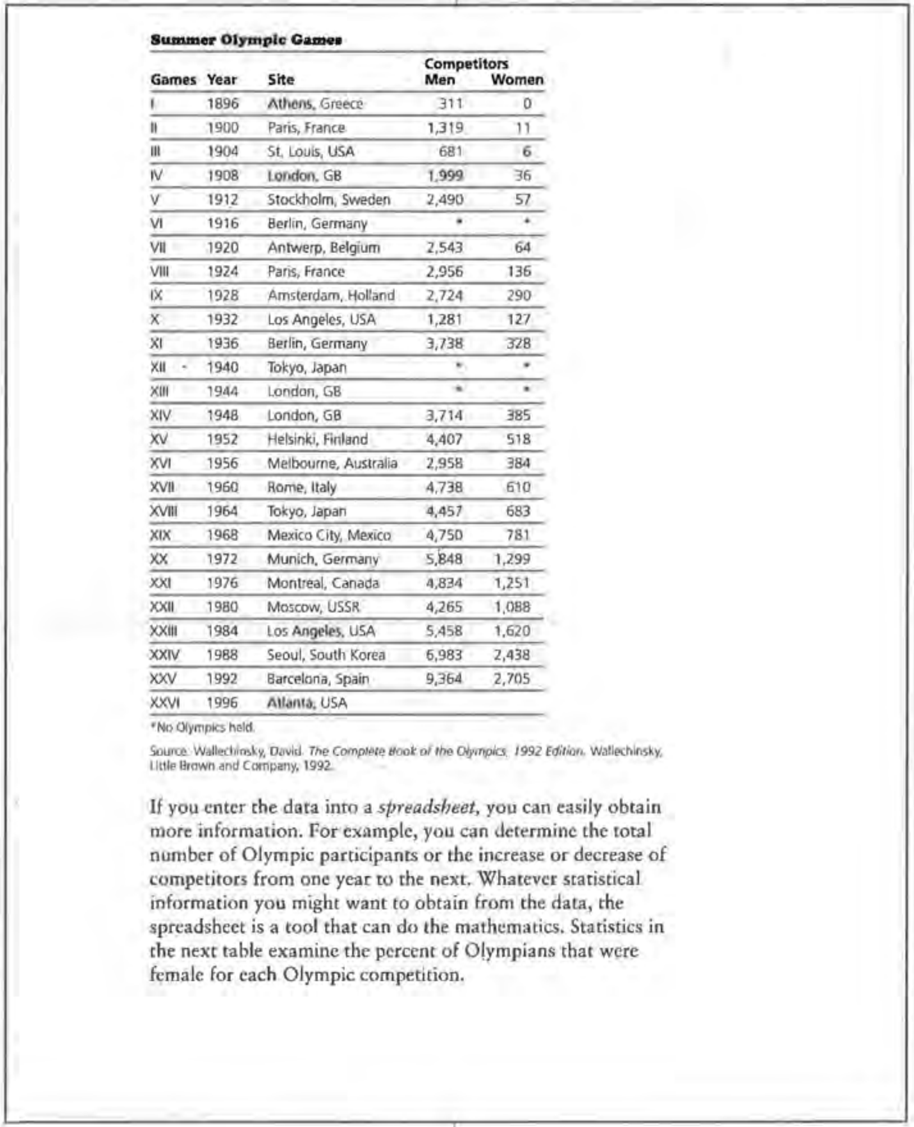
Compute and compare percents.

INVESTIGATE

Frequency Tables

The table that follows shows the number of participants in the Olympic games since 1896. When you look at the number of competitors from the first Olympic games through the twelfth Olympic games, you can see that participation increased.

STUDENT PAGE 90



Summer Olympic Games

Games	Year	Site	Competitors Men	Women
I	1896	Athens, Greece	311	0
II	1900	Paris, France	1,319	11
III	1904	St. Louis, USA	681	6
IV	1908	London, GB	1,999	36
V	1912	Stockholm, Sweden	2,490	57
VI	1916	Berlin, Germany	*	*
VII	1920	Antwerp, Belgium	2,543	64
VIII	1924	Paris, France	2,956	136
IX	1928	Amsterdam, Holland	2,724	290
X	1932	Los Angeles, USA	1,281	127
XI	1936	Berlin, Germany	3,738	328
XII	1940	Tokyo, Japan	*	*
XIII	1944	London, GB	*	*
XIV	1948	London, GB	3,714	385
XV	1952	Helsinki, Finland	4,407	518
XVI	1956	Melbourne, Australia	2,958	384
XVII	1960	Rome, Italy	4,738	610
XVIII	1964	Tokyo, Japan	4,457	683
XIX	1968	Mexico City, Mexico	4,750	781
XX	1972	Munich, Germany	5,848	1,299
XXI	1976	Montreal, Canada	4,834	1,251
XXII	1980	Moscow, USSR	4,265	1,088
XXIII	1984	Los Angeles, USA	5,458	1,620
XXIV	1988	Seoul, South Korea	6,983	2,438
XXV	1992	Barcelona, Spain	9,364	2,705
XXVI	1996	Atlanta, USA		

*No Olympics held.

Source: Wallechinsky, David. *The Complete Book of the Olympics, 1992 Edition.* Wallechinsky, Little Brown and Company, 1992.

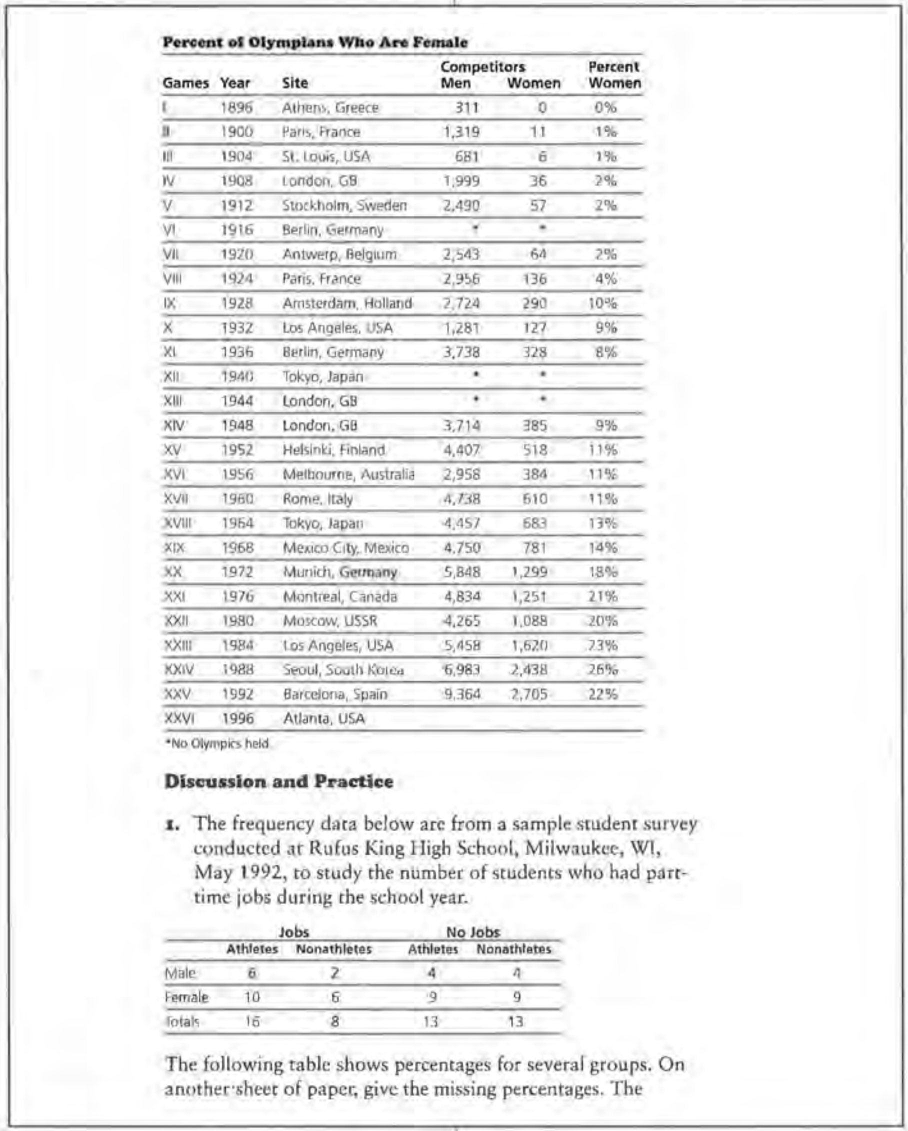
If you enter the data into a *spreadsheet*, you can easily obtain more information. For example, you can determine the total number of Olympic participants or the increase or decrease of competitors from one year to the next. Whatever statistical information you might want to obtain from the data, the spreadsheet is a tool that can do the mathematics. Statistics in the next table examine the percent of Olympians that were female for each Olympic competition.

STUDENT PAGE 91

Solution Key

Discussion and Practice

1. See table below.



Percent of Olympians Who Are Female

Games	Year	Site	Competitors Men	 Women	Percent Women
I	1896	Athens, Greece	311	0	0%
II	1900	Paris, France	1,319	11	1%
III	1904	St. Louis, USA	681	6	1%
IV	1908	London, GB	1,999	36	2%
V	1912	Stockholm, Sweden	2,490	57	2%
VI	1916	Berlin, Germany	*	*	
VII	1920	Antwerp, Belgium	2,543	64	2%
VIII	1924	Paris, France	2,956	136	4%
IX	1928	Amsterdam, Holland	2,724	290	10%
X	1932	Los Angeles, USA	1,281	127	9%
XI	1936	Berlin, Germany	3,738	328	8%
XII	1940	Tokyo, Japan	*	*	
XIII	1944	London, GB	*	*	
XIV	1948	London, GB	3,714	385	9%
XV	1952	Helsinki, Finland	4,407	518	11%
XVI	1956	Melbourne, Australia	2,958	384	11%
XVII	1960	Rome, Italy	4,738	610	11%
XVIII	1964	Tokyo, Japan	4,457	683	13%
XIX	1968	Mexico City, Mexico	4,750	781	14%
XX	1972	Munich, Germany	5,848	1,299	18%
XXI	1976	Montreal, Canada	4,834	1,251	21%
XXII	1980	Moscow, USSR	4,265	1,088	20%
XXIII	1984	Los Angeles, USA	5,458	1,620	23%
XXIV	1988	Seoul, South Korea	6,983	2,438	26%
XXV	1992	Barcelona, Spain	9,364	2,705	22%
XXVI	1996	Atlanta, USA			

*No Olympics held

Discussion and Practice

1. The frequency data below are from a sample student survey conducted at Rufus King High School, Milwaukee, WI, May 1992, to study the number of students who had part-time jobs during the school year.

	Jobs		No Jobs	
	Athletes	Nonathletes	Athletes	Nonathletes
Male	6	2	4	4
Female	10	6	9	9
Totals	16	8	13	13

The following table shows percentages for several groups. On another sheet of paper, give the missing percentages. The

	Jobs		No Jobs	
	Athletes	**Nonathletes**	**Athletes**	**Nonathletes**
Male	12%	4%	8%	8%
Female	**a.** 20%	**b.** 12%	**e.** 18%	**f.** 18%
Totals	**c.** 32%	**d.** 16%	**g.** 26%	**h.** 26%

i. These answers show in each cell the percentages of students out of the fifty students polled. One relationship is apparent in the "no job" category—half are athletes and half are not (26% each). The percentage of athletes with a job is double the percentage of nonathletes with a job.

j. Answers will vary.

k. Male—about 295
Athlete—about 535
Job—about 443
Female with job—about 295

STUDENT PAGE 92

denominator of each fraction is 50, the total number of students in the study.

	Jobs		No Jobs	
	Athletes	Nonathletes	Athletes	Nonathletes
Male	12%	4%	8%	8%
Female	**a.** ?	**b.** ?	**e.** ?	**f.** ?
Totals	**c.** ?	**d.** ?	**g.** ?	**h.** ?

i. List relationships you see in this data table.

j. Write about one relationship. Pick one that may have surprised you and explain why.

k. If Rufus King has a total school population of 923 students, how many would you expect to

- be male?
- be an athlete?
- have a part-time job?
- be a female with a part-time job?

Once data are in a spreadsheet, you can create graphs to provide additional information. Graphic displays can help to highlight trends and get the reader's attention. You may notice many new types of graphs as you look at newspapers and magazines. Artists are employed to make these displays eye-catching and colorful. The graph that follows is a double-bar graph using information from the Summer Olympics table you saw earlier. It shows the frequency of categorical data for male and female participation each year from 1896 to 1984.

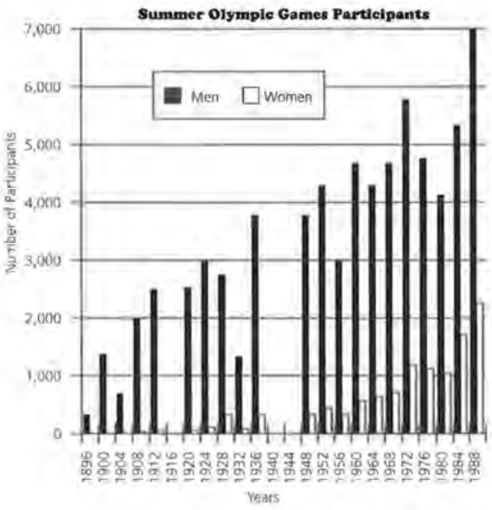
2. To construct a box plot (also called a box-and-whisker plot), the data points must be arranged sequentially.

Participants in the Olympics

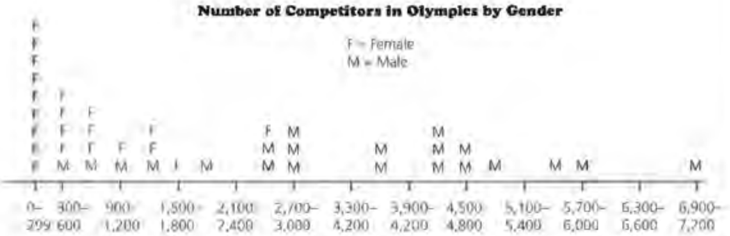
	No. of Males	No. of Females
	311	0
	681	6
	1,281	11
	1,319	36
	1,999	57
Lower quartile median	**2,244.5**	**60.5**
	2,490	64
	2,543	127
	2,724	136
	2,956	290
	2,958	328
Median	**3,714**	**384**
	3,738	385
	4,265	518
	4,407	610
	4,457	683
	4,738	781
Upper quartile median	**4,744**	**934.5**
	4,750	1,088
	4,834	1,251
	5,458	1,299
	5,848	1,620
	6,983	2,438

Be sure to remind students that the median is part of the data set because there is an odd number of data points. For this set of data, the medians of the lower and upper quartiles are not data points but are averages of the points between which they fall.

STUDENT PAGE 93


Summer Olympic Games Participants

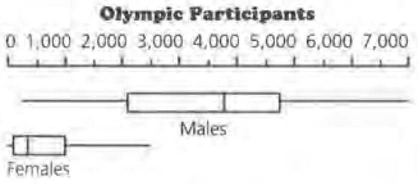
Other plots are box plots, stem-and-leaf plots, line plots, and scatter plots. The line plot below shows participation in the Olympic games by gender since 1896. Note that the discrepancy between males and females is quite obvious.


Number of Competitors in Olympics by Gender

2. Construct two box plots, one for male competitors and the other for female competitors. Write a paragraph comparing the two plots.

3. Use the information on Summer Olympic Games to answer the following:

a. Which years seem to stand out in the data? Explain.


Olympic Participants

The box plot is a dramatic display of the disparity between men and women participating in the Olympics. The median number of men participants is 3,714, while the median number of female participants is a scant 384. The highest number of women participants is only slightly higher than the median of the lower quartile for the men.

3. **a.** 1916, 1940, and 1944 stand out because there were no Olympic games due to the wars. 1980 showed a drop in the number of both men and women.

(3) b. The general trend is that the number of both men and women participating in the Olympics is increasing. This might be due to changes in events.

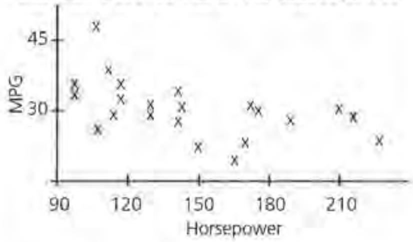
The percent of women participating is increasing although it was still only at 26% in 1988. Students may come up with other trends.

c. The trend of increasing participation was easiest to see on the bar graph. The trend about the increase in percentage of women participating was easiest to see in the table.

4. An appropriate plot is a scatter plot. There is a slight negative association between horsepower and gas mileage. As horsepower increases, mpg has a tendency to decrease.

a.

Scatter Plot of MPG vs. Horsepower



b. Other factors affecting miles per gallon might be weight, driving style (fast, slow), city versus country driving, and options on the car (such as air conditioning).

c. Data can be obtained on factors related to the car, such as weight, but may not be able to be obtained on factors relating to the driver, such as driving style. Often, gas mileage is reported for both city and highway driving.

STUDENT PAGE 94

b. Do you notice any trends in the data? List the trends.

c. Explain one of your observations, or trends, and determine which display makes it easy to "see" your observation.

Practice and Applications

4. The data below show horsepower ratings and average miles per gallon for a selection of cars.

a. Construct an appropriate plot to see if there is any relationship between horsepower and miles per gallon.

b. What factors other than horsepower might affect the gas mileage of a car?

c. What additional data would you need in order to investigate the relationship between the factors you listed in part b and gas mileage?

Horsepower and MPG

Car	Model	Horsepower	Miles per Gallon
Acura	Integra	140	31
BMW	535i	208	30
Buick	Riviera	170	27
Chevrolet	Corsica	110	34
Chevrolet	Astro	165	20
Chrysler	LeBaron	141	28
Dodge	Spirit	100	27
Eagle	Vision	214	28
Ford	Mustang	105	29
Ford	Crown Victoria	190	26
Honda	Civic	102	46
Hyundai	Scoupe	92	34
Lexus	SC300	225	23
Mazda	Protege	103	36
Mercedes-Benz	190E	130	29
Mitsubishi	Mirage	92	33
Nissan	Quest	151	23
Oldsmobile	Silhouette	170	23
Pontiac	Sunbird	110	31
Saab	900	140	26
Subaru	Legacy	130	30
Toyota	Camry	130	29
Volkswagen	Passat	134	30
Volvo	850	168	28

Source: *Journal of Statistics Education*, Vol. I, No. 1, 1993.

INFORMATION SHEET

Informing Others

Materials: none
Technology: word processors (optional)
Pacing: variable

Overview

This lesson is a resource guide to help students become better writers in general and to communicate mathematical concepts in particular.

Teaching Notes

Writing in mathematics classes has not been emphasized over the years. Convincing students that you really do want them to write, revise, rewrite, edit, and so on, will not be easy. Share ideas with teachers in your Language Arts department. They might be able to give you some ideas about what to do to help students develop their writing skills.

The written part of this lesson will take only minutes to do. The time necessary for the remainder of the lesson is up to your discretion.

STUDENT PAGE 95

INFORMATION SHEET

Informing Others

How do you write a good report?

What should you say in your report?

How long should your report be?

OBJECTIVE

Write effective reports.

Writing your project report does not begin after all the other work has been done. A good project report is developed throughout the project. In her book *Writing to Learn Mathematics*, Joan Countryman uses a five-step process to analyze formal writing in mathematics.

Prewriting

In the early stages of writing, you are developing your own mind-set about the project. A journal, an activity log, and your team reports can be excellent ways to keep track of these early ideas about the project.

Drafting

As you move from developing these early ideas to a focus in your project, you can begin to produce early drafts of your report. These could include an outline of the report (just headings and brief phrases to explain the parts as necessary), rough sketches of graphs or layouts, or a concise statement of the problem and an outline of the procedures you plan to use in solving or investigating the problem. Again, a journal, a log, and team reports can help you during this phase of the project.

Revising

This phase of the writing process is actually ongoing and overlapping with the next two steps. You need to develop an attitude that the written word is as easy to reflect on and revise as

STUDENT PAGE 96

the spoken word. Technology, that is, word processing, has helped develop that attitude in recent years. It is more difficult when you are doing your work by hand or by typewriter. In the case of your project, early revisions may have been major at first. You might have had three big ideas for your team's focus and then found that two of them really fizzled. Back to the drawing board! Find a new focus. Revising also includes checks on your progress—are you making progress toward your goals?

Later revisions may be more minor, restricted to changing words, changing labels on graphs, and so on.

Editing

This sounds like revising again, and it is. This time you are nearing completion of the project and are checking for big ideas that are important. As you read our draft copy, think about grammar, spelling, accuracy of displays, format of the pages, and the style points that will mean a high-quality report. The reader can be very easily distracted by errors in writing and might assume that such sloppiness carries over to the data collection itself.

Final Report

This is the final draft. You have read and reread. You have checked and double-checked everything to be sure totals match, graphs correspond, the conclusions are stated, and the sources of your data are well-documented. If you have a computer, save a final copy, lock the computer file, and make a backup disk. Print the report on your best paper with your best printer and turn in a professionally done, on-time report.

Teacher Resources

Overview

MATHEMATICAL CONTENT

The lessons of this module give you and your students opportunities to develop, use, and extend knowledge and skills of mathematics in the context of the data from real-world situations. Unlike other modules in this series, the focus of much of the mathematics will be open to choices, both yours and your students'. All of the modules in *Data-Driven Mathematics* are based on the four themes outlined in 1989 by the National Council of Teachers of Mathematics *Curriculum and Evaluation Standards for School Mathematics:*

Mathematics as Problem Solving
Mathematics as Communication
Mathematics as Reasoning
Mathematical Connections

In addition, the standards specifically addressed in this module are:

GRADES 5–8

Standard 5, Number and Number Relationships

- Understand and apply ratios, proportions, and percents in a wide variety of situations.
- Represent numerical relationships in one- and two-dimensional graphs.

Standard 8, Patterns and Functions

- Describe and represent relationships with tables, graphs, and rules.

Standard 10, Statistics

- Systematically collect, organize, and describe data.
- Construct, read, and interpret tables, charts, and graphs.
- Make inferences and convincing arguments that are based on data analysis.
- Evaluate arguments that are based on data analysis.

Standard 13, Measurement

- Extend understanding of the process of measurement.
- Estimate, make, and use measurements to describe and compare phenomena.

GRADES 9-12

Standard 6, Functions

- Represent and analyze relationships using tables, verbal rules, equations, and graphs.

Standard 10, Statistics

- Construct and draw inferences from charts, tables, and graphs that summarize data from real-world situations.
- Understand and apply measures of central tendency, variability, and correlation.
- Understand sampling and recognize its role in statistical claims.

ASSESSING STUDENTS' KNOWLEDGE AND SKILLS

Opportunities to assess students' knowledge, understanding, and use of these objectives occur daily as the class explores the lessons in the module. The following are ways you may assess students during and after this module. They are described in detail below.

- Peer Evaluations—Have students evaluate each other's work based on a set of criteria.
- Portfolios—Have students select evidence of their work and progress in notebooks or portfolios.
- Observations—You may record evidence in the form of observations. The observation checklist is described on page 122.

- Journals—Have your students develop journal entries that constitute self-reflection and are appropriate for inclusion in a portfolio.
- Rubrics—Use a holistic scoring rubric to rate performance for whichever form of assessment you choose. This is described on page 123.
- Holistic Grading—Comment on general aspects of student performance and assign grades based on comments.
- Grading by Points—Assign points to certain components of students' final projects.
- Quizzes—You may obtain further written evidence by using formal assessments. Included in this section of the Teacher's Edition are short quizzes, which focus on specific knowledge and skills, and performance tasks, which encourage the use of mathematics in integrated, problem-solving situations.

PEER EVALUATIONS

Students can be a part of the assessment process. Place projects from another class (with anonymity guaranteed) around the room. Have the students evaluate the projects on overall clarity by rating them on a 1-to-10 basis. Use this as part of the grade. Groups can also make class presentations on their projects and have the others rate them on a 1-to-10 basis. Class members should be given a set of criteria for rating the projects. Here are some possible criteria:

- clear purpose
- use of graphs
- use of statistics
- clarity of presentation
- contributions by all group members
- ability to respond to questions

As a part of the process, students should record their ratings and their comments in terms of the criteria. These should be shared with the group presenting the project.

You might also want to have students write comments on other members of their groups. Some possible areas they might reflect on are how well each member:

- contributed ideas and information
- acted seriously and maturely about the group work
- listened to others
- stayed on task
- did his or her fair share of the work
- was cooperative throughout the project

PORTFOLIOS

Portfolios are collections of student work that show students' progress through the module. Included are assignments, worksheets, or other material students create. Students select materials to show how they have learned and progressed through the module.

OBSERVATIONS

Observation checklists provide a structure for you to delve beneath the surface of classroom activities and focus on how your students are demonstrating their knowledge, skills, interests, and attitudes. This is important for two reasons. First, you may use the information to give better feedback to students, parents, and others about the progress your students are making mathematically—this is important, in-depth information about students that helps determine their report-card grades. Secondly, ongoing observation plays a key role in instructional planning. When the textbook or curriculum guide forces you along its scope and sequence, you might take a path that does not fit your students. By observing your students' interests, understandings and misunderstandings, and skill development, you can tailor that curriculum plan to maximize their growth and achievement. If these checklists are readily available, you can keep track of student progress and at the same time demonstrate to students that the learning activities count.

To manage the entries, simply write students' names in the spaces on a record sheet like the one at the top of page 123. Then use the checklist to tally evidence about how students are doing on the primary objectives of the module. To tally entries for your class, you could use a three-symbol system: for example, –, +, and *. These can represent observations that indicate inadequate progress, adequate progress, and exemplary work. At the end of a section or grading period, the compilation of observations will present a visual rating scale. This scale can be factored into a grading plan according to an appropriate weighting system along with tests, quizzes, projects, and portfolio ratings.

Name	Number Sense	Reading/ Interpreting	Problem Solving	Extension of Patterns
Student 1	− + + − + * +	+ + + + * *	− − + −	− − + * +
Student 2	− + − + − + +	− − + + + +	+ + + *	− + + * +

JOURNALS

Journal entries are opportunities for student self-reflection. These entries are suitable material for portfolios. A form for a journal entry is provided on *Activity Sheet 10,* which can be used after students complete a unit or even individual lessons.

RUBRICS

You can build a holistic scoring rubric to rate student performance. An assessment system that includes observations, interviews, quizzes, portfolios, and performance assessments implies a different philosophy of measurement than would be applied in traditional grading systems. Students usually have to operate on a *deficit model;* that is, we test to see what students *don't* know, we do it often, and then we apply some weighted averaging to determine grades.

In contrast to that philosophy, the assessment system suggested in this module is one that focuses on what students *can do.* It values their work in progress, it views their work as being steps toward a solution, it emphasizes growth, and it focuses on the whole product, rather than the individual parts. This view of assessment recognizes that tests are really "on-demand" performances and that, in such a situation, it is important for you to have access to the processes the student is using to reach a solution. Unfortunately, many students are not used to leaving such traces of their thoughts in mathematics class. For students to do well in measures of performance, they will need to have practice showing their work, documenting their thought processes, validating their procedures, and defending their methods.

These are exactly the kinds of things the NCTM *Curriculum and Evaluation Standards for School Mathematics* emphasize in the first four standards. It is our job as teachers to help students to see the value in these activities and to inform students about the assessment standards that we will be employing to rate their work.

You will need to develop a scoring rubric for each type of assessment you employ. It helps to be consistent within your own system and to any external system that may be used to measure your students at the district or state level. Here are some basic suggestions:

1. Use terminology that refers to the student *work,* not the student. For example, talk about a proficient response or an adequate response, not about an inadequate student.
2. Keep it simple. A 40-point scale is not going to be helpful. Remember the notion of measurement error. You will not add any precision or accuracy by having too many numbers in your rubric.
3. Be holistic. Although you may consider four or five characteristics of the response, don't let one of them be the overwhelming force.

The sample rubrics below may help you form your own scoring rubric for assessing final projects. But, remember, projects should be work in progress, so encourage revision.

SIX-POINT SCALE

0 = no evidence
1 = clearly inadequate
2 = some progress shown
3 = mixed but mostly inadequate
4 = mixed but mostly adequate
5 = predominantly positive
6 = exemplary

FIVE-POINT SCALE

0 = no evidence
1 = clearly inadequate
2 = low borderline
3 = high borderline
4 = clearly adequate
5 = exemplary

FOUR-POINT SCALE

0 = no evidence
1 = clearly inadequate
2 = marginal
3 = clearly adequate
4 = exemplary

HOLISTIC GRADING

You might also use a holistic form of grading by commenting on the following areas and assigning an overall grade from your comments:

Graphs
Explanations
Organization of survey/experiment
Following directions
Group work
Conclusion

GRADING BY POINTS

There are two possible ways to give grades to the projects. You may give points to each section of the project, such as cover page, question answered, and so on. You choose how to weight each section. A sample form for this type of grading is shown below. Or you may assign points by category, such as following directions, oral presentation, and so on. A sample form for this type of grading is shown at the right.

GRADING EVALUATION SHEET 1

Award points in each of these sections of the project.

___ Cover page (name, participants, cover design)
___ Question to be answered (well-written, clear)
___ Sample surveyed or experiment (specific, thorough)
___ Graph 1 (labels, title, explanation)
___ Graph 2 (labels, title, explanation)
___ Graph 3 (labels, title, explanation)
___ Statistics (if appropriate)
___ Data
___ Conclusion

1. What are your main conclusions from this project?
2. What would you do differently if you were to repeat this project?
3. What additional work could be done on this project if you had time?

___ **Total**

Comments:

GRADING EVALUATION SHEET 2

Award points in each of these categories.

___ Ability to organize procedures and follow directions 25 points

Comments:

___ Clarity of tables and graphs 25 points

Comments:

___ Quality of written report 25 points

Comments:

___ Quality of oral presentation 25 points

Comments:

___ Additional points for creativity 10 points

Comments:

QUIZZES

The quizzes for the units in this module begin on page 125. As with other activity sheets in this module, these may be reproduced and distributed to students. The answers are on page 129.

Censuses

NAME ______________________________

1. You wish to take a census of your school to find out how many students say the Pledge of Allegiance during morning announcements.

a. Describe your plan for carrying out this census. Be sure to define your population and to tell exactly how your plan will work.

b. Name two problems you expect to have while carrying out your census.

2. For each situation below, tell if the data set collected is a census or not. If you think it *is* a census, describe a method that will ensure that every member of the population will be counted only once. If you think it *is not* a census, explain why.

a. Marcus checks the price of the latest *Boyz II Men* CD at every store listed in the yellow pages of the telephone book.

b. Maria stops everyone coming out of the biggest grocery store in town and asks if he or she prefers paper or plastic.

c. A forest ranger sets a squirrel trap every night. If a squirrel is caught, it is weighed and tagged and then released. If a tagged squirrel is caught, it is released. The ranger figures that in a year he will have weighed and tagged every squirrel in the forest.

Surveys

NAME

1. For each survey below, tell if bias is present or not. Explain your answer.

a. A telephone survey beings with, "How about those Red Sox! Think they'll make the playoffs this year?"

b. A police officer asks students in the eighth grade if they smoke or not.

c. A nicely dressed woman asks department store customers if they have eaten chicken this week.

Read the following article concerning the baseball strike.

Minor Leaguers Set To Sign On

By Mel Antonen, *USA Today*, January 10, 1995

Minor league free agents are expected to help make up baseball's replacement teams, and 39% say they will definitely or probably sign to replace major league players, who have been on strike since Aug. 12.

Of 125 minor league free agents surveyed by *USA Today*, 25 said they would definitely play and another 24 said they would probably play.

There are 416 minor league free agents, and the survey's findings project teams could sign 163 players—or enough to fill about $6\frac{1}{2}$ of the 28 major league rosters.

General managers say they can field replacement teams from within their systems, without allowing top prospects to be used.

After minor league free agents, GMs will turn to minor leaguers with less experience, recently retired players, college players and major leaguers willing to cross the picket line.

Houston pitcher Greg Swindell says he might cross, but other union players say no way.

"It was clear across the board that nobody was going to cross," said New York Yankees catcher Mike Stanley after a meeting with 100 players Sunday. "If you are wise about your finances, you should be pretty well qualified to get through the year."

Source: *USA Today*, January 10, 1995

2. Answer the following questions:
    - a. What was the population surveyed?
    - b. How many people were in the sample?
    - c. How do you think the players sampled were selected?
    - d. What conclusion was drawn from the survey?

Experiments

NAME ______________________________

1. Emil is conducting an experiment to determine reaction time. He places a spoon in the middle of a table that separates two people, a man and a woman. The right hand of each person is placed flat on the table at the right of the spoon. Emil shuffles a deck of playing cards and turns up one card at a time. When the card turned over is a face card—king, queen, or jack—both persons attempt to grab the spoon. Emil records the results and the experiment is repeated 11 times or until one person has six spoons. The winner is the person who first collects six spoons.

Emil plans to conduct this experiment with the parents of ten of his best friends and report on the reaction times based on the results for males and females. Suggest ways that Emil could improve the design of this experiment.

2. Gail is experimenting with a method of predicting a person's height by measuring the person's wrist. To test the idea, Gail gathered the following data.

Males (Wrist, Height) in Inches	Females (Wrist, Height) in Inches
(7.125, 73)	(5.875, 63)
(6.5, 70)	(6.125, 64)
(7.24, 71)	(6.5, 63.5)
(7.0, 67)	(6.0, 63)
(7.5, 74)	(6.0, 66)

a. Use these 10 data points to make some generalizations about the relationship between the measurements of a person's height and wrist. Plot these points on a scatter plot and describe the relationship between the two variables.

b. Write a letter to Gail giving your opinion of this experiment and advice on how to conduct and report on the results.

Unit I: Censuses

1. a. Plans will vary.

b. Problems that might arise include:
Some students may be absent.
Some students may be suspended or expelled.
There may not be time to conduct the census.
It may be difficult to collate the data.
Some students may not be truthful.
Some students may choose to not answer.

2. a. If Marcus calls every store and his population is stores in the yellow pages, then this is a census. He would have to keep a record to show that he called each store only one time.

b. Any result would be valid only for that store during that time period. However, it most likely will not be a census. Not everyone will answer the question. At times, groups of people might exit the store at the same time. It would be difficult to get to all people. The results really depend on the question Maria is asking and the population in whose response she is interested.

c. This is not a census. There is no way of knowing if all the squirrels have been counted.

Unit II: Surveys

1. a. This is a biased approach. Obviously, the questioner supports the Red Sox. This would make the respondent feel the need to answer that he or she feels the Red Sox would make the playoffs.

b. This statement also entails bias. Students are intimidated by the police. Since it is against the law for eighth graders to smoke, few would answer honestly.

c. There is no bias in this question or in the approach.

2. a. The population was the number of free agents, 416.

b. 125 were sampled.

c. There were a variety of ways free agents could have been sampled. They were probably called, but there is no information in the article about the process.

d. The survey concluded that there would only be enough players to staff about $6\frac{1}{2}$ teams using free agents.

Unit III: Experiments

1. There are many ways Emil could change the design of his experiment. They may or may not be improvements.

- First he must determine exactly what he wants to know. His question could be, "Who has the faster reaction time, men or women?"
- Emil would have to be sure the people he is testing have the same dominant hand.
- Age could be a factor, so he could control for age.
- Instead of dealing cards, Emil could ring a bell and have the subjects reach for the spoon when they hear the bell.

2. a. The "least squares" line that fits through these data is approximately: height = 26.2 + (6.3)(wrist measurement). This line can be used to predict the height of a person based upon the size of a person's wrist.

b. There will be great variety in the letters written. Look for some mathematical substance when grading them. You must use a holistic grading scale. Some points to consider are:

- All of the males in the study were quite tall. Could this make a difference?
- Are 12 data points enough to develop a pattern for prediction?

ACTIVITY SHEET 1

Unit I Activity: Taking Your Own Census

NAME ______________________________

CENSUS QUESTIONS

Pass out this list of questions to every student in your class (or grade or school, if you wish to have a larger population). Assure the people you ask to fill out the questionnaire that their answers will be completely confidential and that only summary data will be reported. Be sure to tell them "thank you" for taking the time to fill out the questionnaire.

1. How old are you?
    ___ Younger than 12
    ___ 12
    ___ 13
    ___ 14
    ___ 15
    ___ 16
    ___ 17
    ___ 18
    ___ 19
    ___ Older than 19

2. What is your gender?
    ___ Male
    ___ Female

3. Do you plan to get married?
    ___ Yes
    ___ No

4. Do you plan to have children? (If "no," skip to question 6.)
    ___ Yes
    ___ No

5. How many children would you like to have?
    ___ 1
    ___ 2
    ___ 3
    ___ 4
    ___ 5
    ___ 6
    ___ 7 or more

6. After high school, which of the following do you plan to do?
    ___ Attend a two-year college
    ___ Attend a four-year college
    ___ Go to a trade or vocational school
    ___ Join the Armed Forces
    ___ Get a full-time job
    ___ None of these

7. Of the following occupations, which one would you most like to pursue after school?
    ___ Doctor
    ___ Teacher
    ___ Social Worker
    ___ Lawyer
    ___ Computer Programmer
    ___ Stockbroker
    ___ Firefighter
    ___ Hairdresser
    ___ Mechanic
    ___ Carpenter
    ___ Truck Driver
    ___ Law Enforcement
    ___ Farmer
    ___ None of these

8. Of the following occupations, which one would you least like to pursue after school?
    ___ Doctor
    ___ Teacher
    ___ Social Worker
    ___ Lawyer
    ___ Computer Programmer
    ___ Stockbroker
    ___ Firefighter
    ___ Hairdresser
    ___ Mechanic
    ___ Carpenter
    ___ Truck Driver
    ___ Law Enforcement
    ___ Farmer
    ___ None of these

Source: "That's Easy for You to Say!" Department of Commerce, Bureau of the Census, August 1988

ACTIVITY SHEET 2

Lesson 5: Selecting a Sample/Lesson 6: Studying Randomization

NAME ____

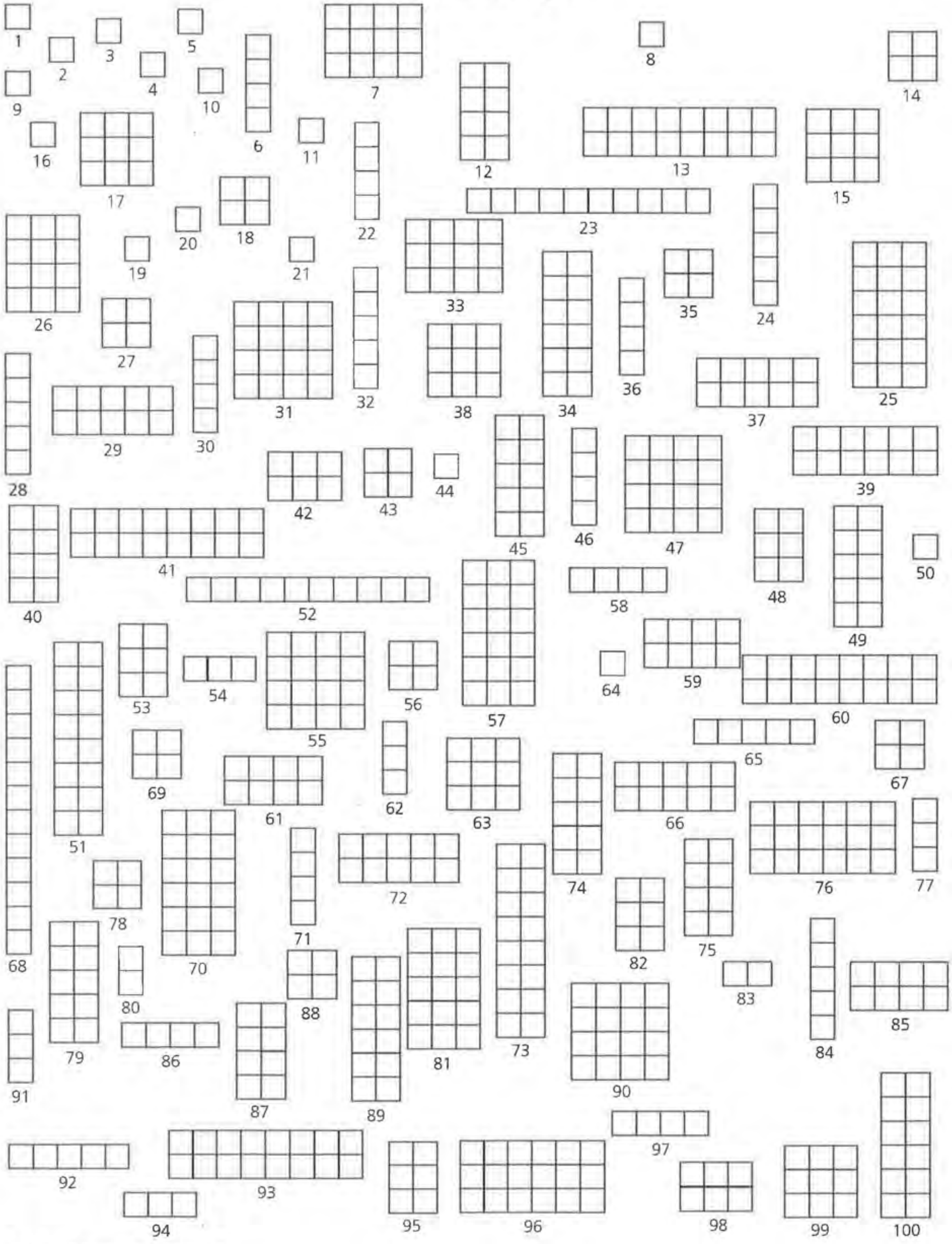
TABLE OF RANDOM NUMBERS

59718	77768	50032	53440	41359	33021	01938	86092	87426	80010
91977	35682	34043	26290	40447	12411	32837	12151	21227	81491
88224	92826	92683	66928	95518	70106	92397	62132	97206	26324
01288	56565	78378	72344	12566	58325	40257	93212	49208	51320
19483	45024	12857	46267	94007	98674	54199	29738	24084	91964
33652	12588	55326	05702	43815	61284	13606	65461	70415	91440
32207	57357	18841	61415	57755	46846	41422	35285	37870	55929
99945	87321	41676	70537	39314	45154	93823	14053	81888	11464
29773	64388	95180	80750	12815	77661	89578	42194	99329	21247
92329	55414	05162	94197	19267	68846	27895	12005	80292	49745
75834	71767	45378	40316	61259	13140	66115	61564	76757	62599
22755	89933	41019	18996	13005	31853	72795	22193	59897	62049
09056	73260	95209	33157	15608	37565	93590	85486	80932	76059
66250	96883	74585	74550	89984	28356	77938	69704	19034	19744
37052	83115	38995	52825	93308	75276	21274	48777	75400	62004
81653	74197	85789	50614	52742	48213	94759	80701	08234	44686
41417	37426	42282	34323	83341	38345	83018	25015	68282	94820
27862	25188	15227	90981	06296	86815	04322	44750	01554	91302
85083	13672	29208	17587	12217	24032	52318	83860	81936	29114
05649	48381	63320	11822	11590	75112	54027	56579	81397	14691
91654	28637	01627	24482	33119	29924	69390	85040	66927	63521
43540	82299	18928	35588	55113	78385	61536	49596	05202	40993
33276	99974	62800	97999	56683	61505	85617	32656	16834	88980
18139	96834	07488	32049	53532	12159	75508	10924	25298	96474
07403	42795	55422	49346	44612	61632	81241	04660	95163	16285
05374	34289	66087	74636	64247	73598	42730	79472	79834	72702
63121	17926	84377	16927	91950	26475	10086	61879	03475	64750
66148	59081	34743	69023	50306	63739	14717	32374	19119	96284
92153	23320	34180	78025	42391	35908	73996	49173	47360	92856
06629	93991	80847	49133	45105	34818	10122	31369	33312	94856
74784	07080	13104	64110	98440	56468	88959	67988	58764	70414
59043	74797	24791	65130	97918	99820	32673	44512	36847	14028
58572	79127	74870	47218	03752	92434	71791	28040	60536	37429
75069	76687	43795	50161	20794	95015	42376	33178	10265	03394
72258	09820	54814	84454	32761	59316	14974	80017	37524	25760
16186	64983	27652	53966	75826	16790	13767	52267	65505	56954
54047	17961	92967	27968	12463	85270	13763	96297	43279	93087
42301	36874	19357	14982	22806	69213	79929	48973	21969	28172
87940	43389	26009	52702	03148	70789	88539	19084	59200	88168
91551	24267	81423	17461	09300	11928	98793	97748	95430	11644
03166	69589	65596	56997	70092	63418	92825	91586	76847	51167
64280	45356	96248	79274	15733	72317	44107	80124	99627	44523
28464	37825	88800	20180	28989	75914	46882	28736	60408	63180
36861	76806	80789	30886	71013	56044	52405	81063	04283	41256
43125	34876	18177	22382	37920	77067	93319	29881	37050	32533

Lesson 6: Studying Randomization

NAME ______________________________

100 Random Rectangles



ACTIVITY SHEET 4

Unit II Activity: Conducting Your Own Survey

NAME ______________________________

A STATISTICAL SAMPLE SURVEY PLAN

Survey Title: ______________________________

Team Members: ______________________________

The objective(s) of our survey is (are): ______________________________

____

____

Based on our objective(s), we will ask the following question(s): ______________________________

____

____

The target population will be: ______________________________

The number of people in our sample will be: ______________________________

To minimize sampling bias, we will select our sample this way: ______________________________

____

____

We will field test our sample survey on this date: ______________________________

We will survey this many people: ______________________________

When we evaluated our field-test results, we identified the following problems: ______________________________

____

____

We then redesigned our survey in the following way: ______________________________

____

____

Teacher signature for approval: ______________________________

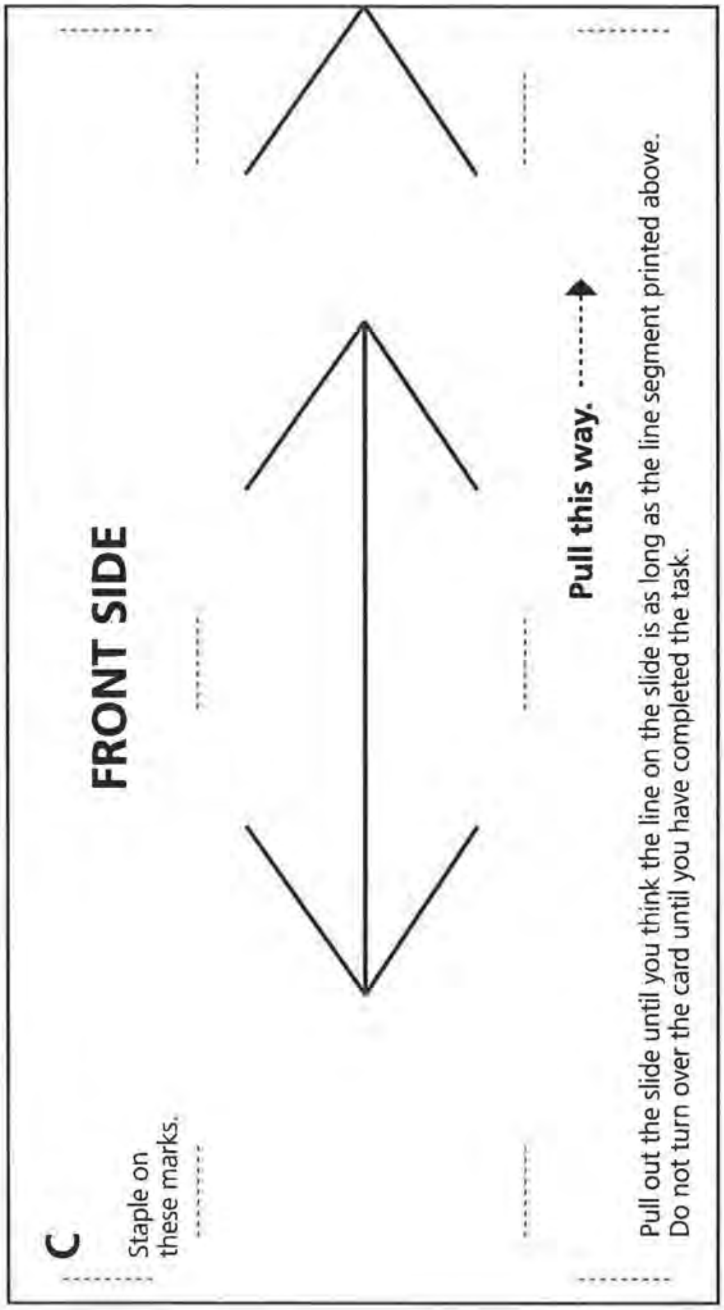
Date: ______________________________

Lesson 12: Measurement Variability and Bias

NAME ______________________________

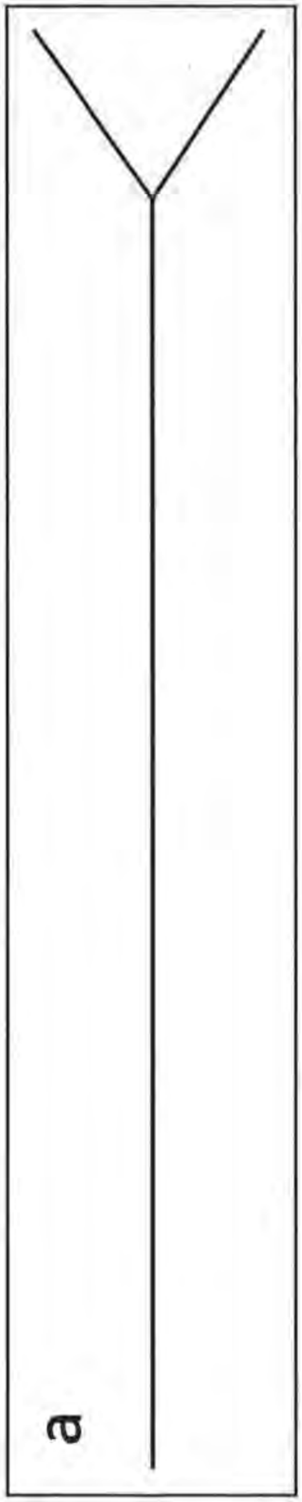
LENGTH BIAS EXPERIMENT

1. Cut out all the rectangles on these two pages.
2. Glue pieces a and b with back sides together. This is the "slide."
3. Now put pieces c and d together, back sides together, by stapling them at the dotted lines on the front of piece c. There are ten places to staple. This is the "jacket."



Staple on these marks.

Pull out the slide until you think the line on the slide is as long as the line segment printed above. Do not turn over the card until you have completed the task.

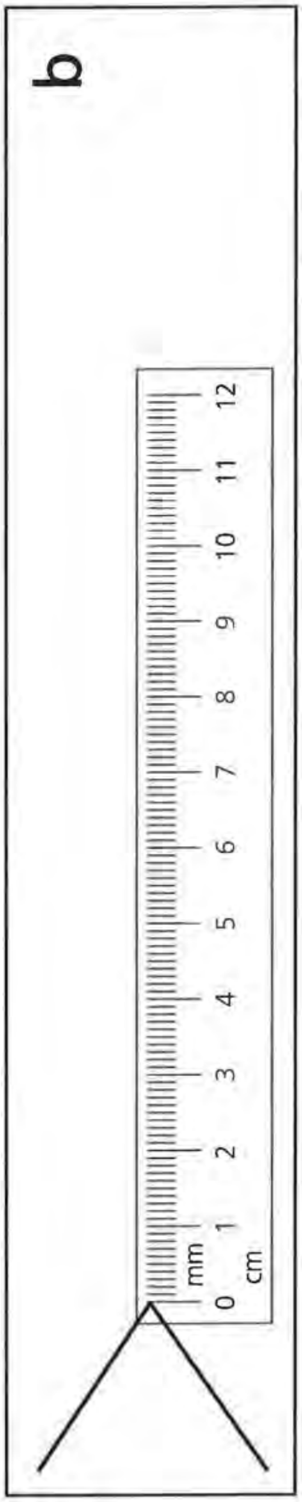


ACTIVITY SHEET 5 (CONT.)

Lesson 12: Measurement Variability and Bias

NAME ______________________________

4. Insert the slide, front side up, into the jacket so it slides left and right.
5. From the right side of the jacket, pull the slide out until the line on the slide appears to be the same length as the line on the jacket. Turn the whole thing over and read the ruler on the slide to find out what length you guessed.



Project Requirements

NAME ____

SELECT A TOPIC

Here are some ideas:

1. Make up an "event" on which to test people. For example, how long can you hold your breath? How far can you jump? How fast can you recite the alphabet?
2. Ask about some "like" or preference. Be sure you have two or three groups so you can make comparisons.
3. Do some product testing. How many kernels of popcorn are left in different brands of microwave popcorn? How many raisins are in different brands of raisin bran cereal?

SET UP YOUR SURVEY, CENSUS, OR EXPERIMENT

If you are doing a survey, make sure that every person gets an equal opportunity of being chosen (randomness). Make sure your questions are not biased. If you are doing an experiment, make sure you use standard testing procedures. Make sure you have some type of control group. Also do the following:

- Select a target population (survey or census) or a treatment (experiment).
- Decide how to gather your data.
- Field test your questionnaire or experimental procedure.
- Collect data.
- Organize the data. Prepare graphs.
- Analyze the data. Write a statistical summary if needed.

PREPARE YOUR WRITTEN PROJECT

You need to write a report on your project. Here is one way to organize the report:

Page 1: Include the name of the study and the names of the participants. It should include some type of artwork that is representative of your study.

Page 2: Write the question you worked on; that is, what were you trying to find out?

Page 3: Tell how you selected the sample you surveyed or how you set up your experiment.

Pages 4, 5, and 6: You should have at least three graphs that help to answer your question. Each axis must be labeled. Each graph must be named. There must be a written explanation for each graph specifying what that graph is telling the reader. You will get bonus points if you include extra graphs.

Project Requirements

NAME ____

Pages 7 and up: Include all statistics you have, including mean, median, range, maximum, minimum, if they are appropriate. Include all raw data.

Final Page: Write a conclusion.

1. List any findings or conclusions you made from the study.
2. Tell what you would have done differently if you were doing the study over again.
3. Tell what else you could have done with this study.

ACTIVITY SHEET 7

Project Requirements Checklist

NAME ____

I. Preliminary Presentation

Due Date________

On a 4-by-6-inch file card, print the following information:

1. Your name and your partners' name(s) if you are a group.
2. What question are you investigating?
3. What is your population?
4. How will you gather your data?
5. Will you be using a survey?
6. How will you get a random sample?

II. Personal Progress Report

Due Date________

In a large envelope, organize the following items:

1. Your data in its original form.
2. A copy of any questionnaires or surveys you developed.
3. Graphs that helped you explore your data.
4. Computer printouts that helped you analyze your data.
5. A brief progress report typed or written in ink.
6. A list of any references that you used.

III. First Draft

Due Date________

1. Cover sheet with project title, your name, and the date.
2. A table of the data you used and the method that you used to gather the data.
3. Graphs that reveal information about your data.
4. Analysis of the data.
5. Additional questions that your data generated.
6. Summary statement that answers your original question.

IV. Final Draft

Due Date________

1. Report should by typed on 8.5-by-11-inch white paper. Please do not select a type that is hard to read.
2. All graphs and tables should be mounted carefully on standard paper and photocopied.
3. Your final cover sheet may be illustrated.
4. Provide clear and concise statement of your conclusions.

V. Evaluation

1.	Organization and following directions	________ 25
2.	Clarity of tables and graphs	________ 25
3.	Quality of written report	________ 25
4.	Quality of oral presentation	________ 25
5.	Additional points for creativity	________ 10

Prepared by Gretchen Davis, Santa Monica High School, Santa Monica, California

ACTIVITY SHEET 8

Writing a Statistical Summary

NAME ______________________________

A statistical summary is a blend of words and numbers that tells the reader the following:

1. Where did the data come from and how were they collated?
2. What do the data represent?
3. Is there anything unusual in the numbers themselves?
4. What is the range?
5. What is the center? Describe it.
6. Describe the spread.
7. Are there any outliers?
8. What are the points of interest: where do they cluster and what do they represent, where am I in relation to the data set?

Here is a possible format:

The data we studied came from ______________________.

They were collected by ______________________.

and represent ______________________.

The greatest value ____________ is at ____________. The least value is at ____________. The average ____________ is ____________. Half of the ____________ are greater than ____________. The ____________ in the middle are from ____________ to ____________.

The outliers are ______________________.

This might be because ______________________.

Of particular interest is ______________________

because ______________________.

Source: From *Home Runs to Housing Costs*, ed. Gail Burrill, Menlo Park, CA: Dale Seymour Publications, 1994, p. 10

ACTIVITY SHEET 9

Portfolio Assessment

NAME ____

Use this sheet after you have completed the module. As you complete your portfolio, be sure to include work that shows your ability to:

- design a survey or experiment to collect information about a clearly stated question or problem
- conduct a survey or experiment, collecting accurate information related to your question or problem
- organize, display, and analyze the information collected through your survey or experiment
- report clearly and effectively about your findings and to support those findings using data, mathematics, and reasoning
- reflect on the quality of your work in this module and on your understandings and skills

ACTIVITY SHEET 10

Journal Writing

NAME ______________________________

DATE

1. My favorite lesson or activity in this unit was: ______________________________

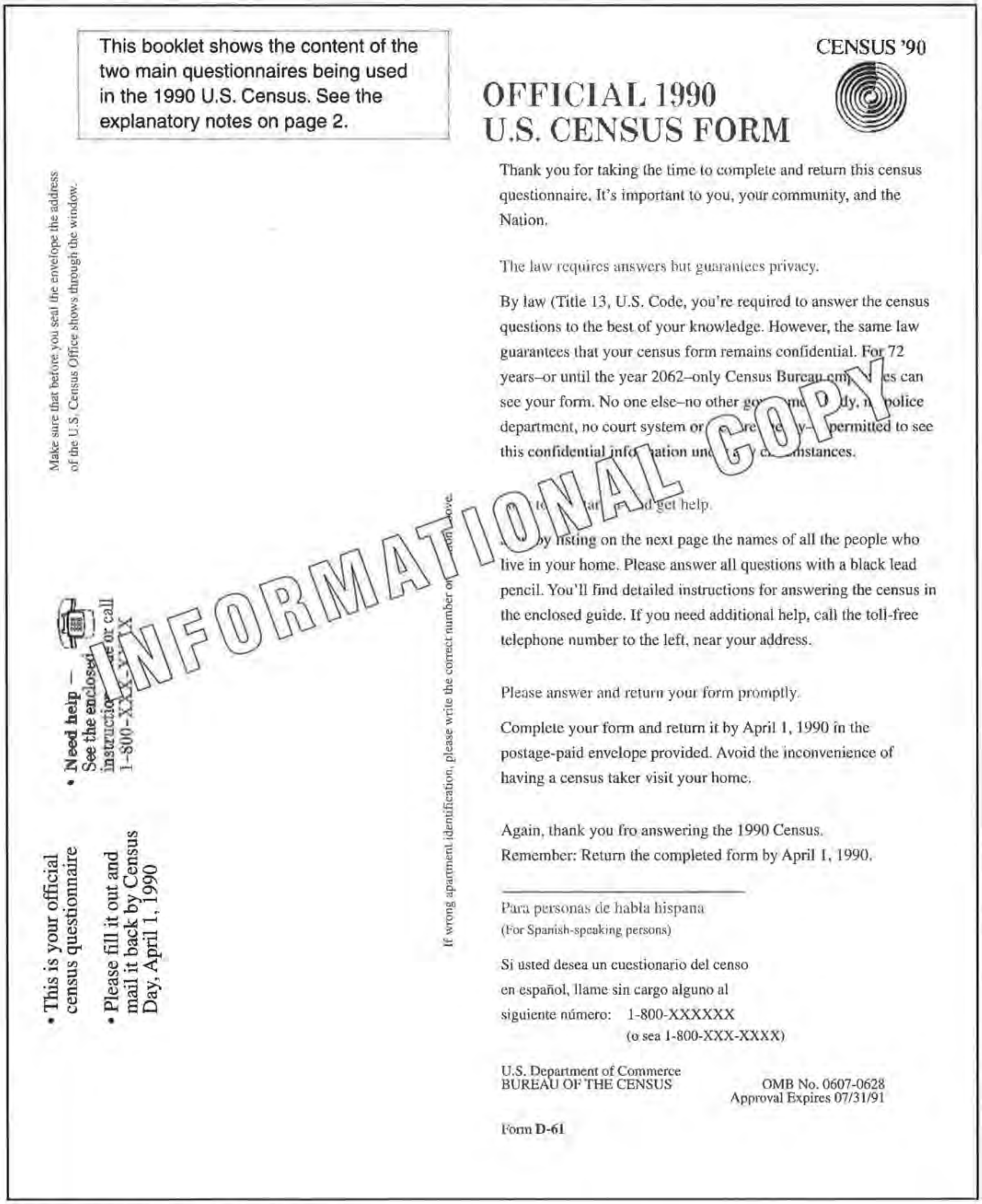
Because: ______________________________

2. The mathematical idea I feel most comfortable with in this unit is: ______________________________

The mathematical idea that I need to work most on is: ______________________________

3. The statistics idea that I learned the most about in this section is: ______________________________

I need answers to these statistical questions: ______________________________



This booklet shows the content of the two main questionnaires being used in the 1990 U.S. Census. See the explanatory notes on page 2.

Make sure that before you seal the envelope the address of the U.S. Census Office shows through the window.

- This is your official census questionnaire
- Please fill it out and mail it back by Census Day, April 1, 1990
- **Need help** — ☎ See the enclosed instruction guide or call 1-800-XXX-XXXX

If wrong apartment identification, please write the correct number on [illegible] above.

CENSUS '90

OFFICIAL 1990 U.S. CENSUS FORM

Thank you for taking the time to complete and return this census questionnaire. It's important to you, your community, and the Nation.

The law requires answers but guarantees privacy.

By law (Title 13, U.S. Code, you're required to answer the census questions to the best of your knowledge. However, the same law guarantees that your census form remains confidential. For 72 years–or until the year 2062–only Census Bureau employees can see your form. No one else–no other government body, no police department, no court system or other agency–is permitted to see this confidential information under any circumstances.

[illegible] to start and get help.

Start by listing on the next page the names of all the people who live in your home. Please answer all questions with a black lead pencil. You'll find detailed instructions for answering the census in the enclosed guide. If you need additional help, call the toll-free telephone number to the left, near your address.

Please answer and return your form promptly.

Complete your form and return it by April 1, 1990 in the postage-paid envelope provided. Avoid the inconvenience of having a census taker visit your home.

Again, thank you fro answering the 1990 Census.
Remember: Return the completed form by April 1, 1990.

Para personas de habla hispana
(For Spanish-speaking persons)

Si usted desea un cuestionario del censo
en español, llame sin cargo alguno al
siguiente número: 1-800-XXXXXX
(o sea 1-800-XXX-XXXX)

U.S. Department of Commerce
BUREAU OF THE CENSUS

OMB No. 0607-0628
Approval Expires 07/31/91

Form **D-61**

The 1990 Census Questionnaire

Page 1

The 1990 census must count every person at his or her "Usual residence." This means the place where the person lives and sleeps most of the time.

1a. List on the numbered lines below the name of each person living here on Sunday, April 1, including all persons staying here who have no other home. If EVERYONE at this address is staying here temporarily and usually lives somewhere else, follow the instructions given in question 1b below.

Include	Do NOT include
• Everyone who usually lives here, such as family members, housemates and roommates, foster children, roomers, boarders, and live-in employees	• Persons who usually live somewhere else
• Persons who are temporarily away on a business trip, on vacation, or in a general hospital	• Persons who are away in an institution such as a prison, mental hospital, or a nursing home
• College students who stay here while attending college	• College students who live somewhere else while attending college
• Persons in the Armed Forces who live here	• Persons in the Armed Forces who live somewhere else
• Newborn babies still in the hospital	
• Children in boarding schools below the college level	
• Person who stay here most of the week while working even if they have a home somewhere else.	• Persons who stay somewhere else most of the week while working
• Persons with no other home who are staying here on April 1	

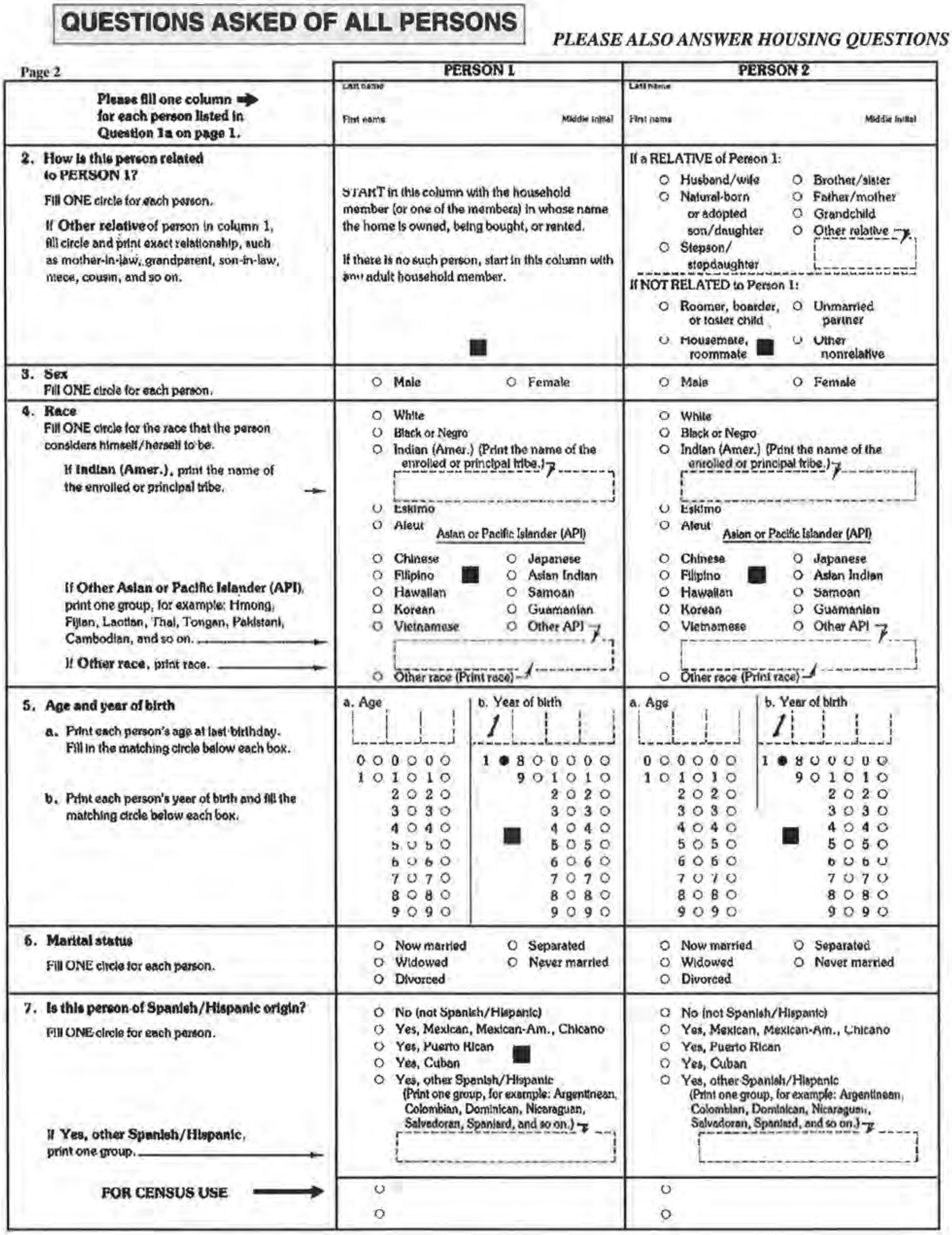
Print last name, first name, and middle initial for each person. BEgin on line 1 with the household member (or one of the household members) in whose name this house or apartment is owned, being bought, or rented. If there is no such person, start on line 1 with any adult household member.

	LAST	FIRST	INITIAL		LAST	FIRST	INITIAL
1				7			
2				8			
3				9			
4				10			
5				11			
6				12			

1b. If EVERYONE is staying here only temporarily and usually lives somewhere else, list the name of each person on the numbered lines above, fill this circle and print their usual address below. → ○
DO NOT PRINT THE ADDRESS LISTED ON THE FRONT COVER.

House number | Street or road/Rural route and box number | Apartment number

The 1990 Census Questionnaire



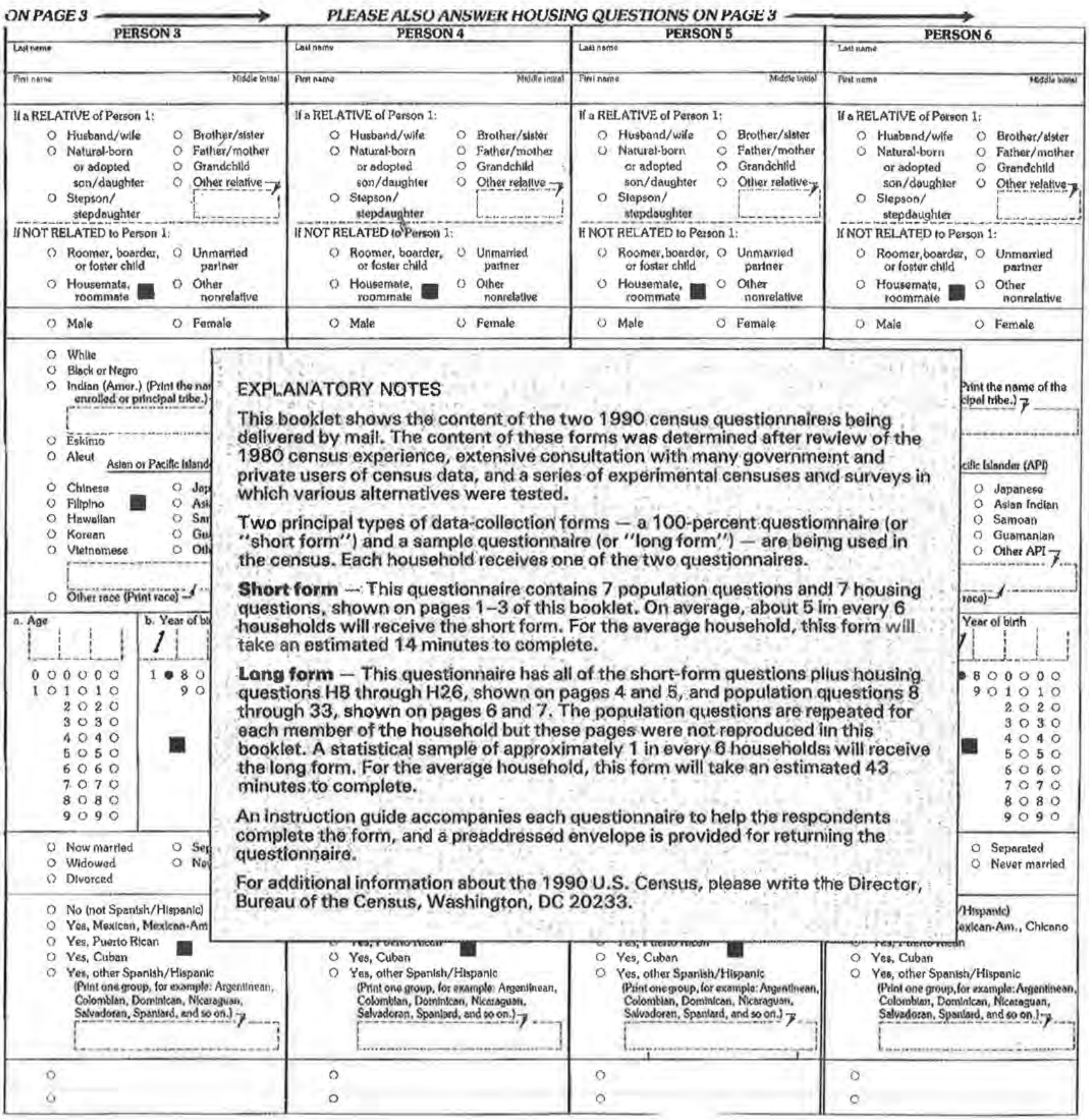
QUESTIONS ASKED OF ALL PERSONS

PLEASE ALSO ANSWER HOUSING QUESTIONS

Page 2

	PERSON 1	PERSON 2
Please fill one column ➡ for each person listed in Question 1a on page 1.	Last name First name Middle initial	Last name First name Middle initial
2. How is this person related to PERSON 1? Fill ONE circle for each person. If **Other relative** of person in column 1, fill circle and print exact relationship, such as mother-in-law, grandparent, son-in-law, niece, cousin, and so on.	START in this column with the household member (or one of the members) in whose name the home is owned, being bought, or rented. If there is no such person, start in this column with any adult household member.	If a RELATIVE of Person 1: ○ Husband/wife ○ Natural-born or adopted son/daughter ○ Stepson/stepdaughter ○ Brother/sister ○ Father/mother ○ Grandchild ○ Other relative If NOT RELATED to Person 1: ○ Roomer, boarder, or foster child ○ Housemate, roommate ○ Unmarried partner ○ Other nonrelative
3. Sex Fill ONE circle for each person.	○ Male ○ Female	○ Male ○ Female
4. Race Fill ONE circle for the race that the person considers himself/herself to be. If **Indian (Amer.)**, print the name of the enrolled or principal tribe. → If **Other Asian or Pacific Islander (API)**, print one group, for example: Hmong, Fijian, Laotian, Thai, Tongan, Pakistani, Cambodian, and so on. → If **Other race**, print race. →	○ White ○ Black or Negro ○ Indian (Amer.) (Print the name of the enrolled or principal tribe.) ○ Eskimo ○ Aleut Asian or Pacific Islander (API) ○ Chinese ○ Japanese ○ Filipino ○ Asian Indian ○ Hawaiian ○ Samoan ○ Korean ○ Guamanian ○ Vietnamese ○ Other API ○ Other race (Print race)	○ White ○ Black or Negro ○ Indian (Amer.) (Print the name of the enrolled or principal tribe.) ○ Eskimo ○ Aleut Asian or Pacific Islander (API) ○ Chinese ○ Japanese ○ Filipino ○ Asian Indian ○ Hawaiian ○ Samoan ○ Korean ○ Guamanian ○ Vietnamese ○ Other API ○ Other race (Print race)
5. Age and year of birth **a.** Print each person's age at last birthday. Fill in the matching circle below each box. **b.** Print each person's year of birth and fill the matching circle below each box.	a. Age 0 ○ 0 ○ 0 ○ 1 ○ 1 ○ 1 ○ 2 ○ 2 ○ 3 ○ 3 ○ 4 ○ 4 ○ 5 ○ 5 ○ 6 ○ 6 ○ 7 ○ 7 ○ 8 ○ 8 ○ 9 ○ 9 ○ b. Year of birth 1 1 ● 8 ○ 0 ○ 0 ○ 9 ○ 1 ○ 1 ○ 2 ○ 2 ○ 3 ○ 3 ○ 4 ○ 4 ○ 5 ○ 5 ○ 6 ○ 6 ○ 7 ○ 7 ○ 8 ○ 8 ○ 9 ○ 9 ○	a. Age 0 ○ 0 ○ 0 ○ 1 ○ 1 ○ 1 ○ 2 ○ 2 ○ 3 ○ 3 ○ 4 ○ 4 ○ 5 ○ 5 ○ 6 ○ 6 ○ 7 ○ 7 ○ 8 ○ 8 ○ 9 ○ 9 ○ b. Year of birth 1 1 ● 8 ○ 0 ○ 0 ○ 9 ○ 1 ○ 1 ○ 2 ○ 2 ○ 3 ○ 3 ○ 4 ○ 4 ○ 5 ○ 5 ○ 6 ○ 6 ○ 7 ○ 7 ○ 8 ○ 8 ○ 9 ○ 9 ○
6. Marital status Fill ONE circle for each person.	○ Now married ○ Separated ○ Widowed ○ Never married ○ Divorced	○ Now married ○ Separated ○ Widowed ○ Never married ○ Divorced
7. Is this person of Spanish/Hispanic origin? Fill ONE circle for each person. If **Yes, other Spanish/Hispanic**, print one group. →	○ No (not Spanish/Hispanic) ○ Yes, Mexican, Mexican-Am., Chicano ○ Yes, Puerto Rican ○ Yes, Cuban ○ Yes, other Spanish/Hispanic (Print one group, for example: Argentinean, Colombian, Dominican, Nicaraguan, Salvadoran, Spaniard, and so on.)	○ No (not Spanish/Hispanic) ○ Yes, Mexican, Mexican-Am., Chicano ○ Yes, Puerto Rican ○ Yes, Cuban ○ Yes, other Spanish/Hispanic (Print one group, for example: Argentinean, Colombian, Dominican, Nicaraguan, Salvadoran, Spaniard, and so on.)
FOR CENSUS USE ➡	○ ○	○ ○

The 1990 Census Questionnaire



ON PAGE 3 → PLEASE ALSO ANSWER HOUSING QUESTIONS ON PAGE 3 →

PERSON 3	PERSON 4	PERSON 5	PERSON 6
Last name	Last name	Last name	Last name
First name Middle initial	First name Middle initial	First name Middle initial	First name Middle initial
If a RELATIVE of Person 1: ○ Husband/wife ○ Brother/sister ○ Natural-born or adopted son/daughter ○ Father/mother ○ Grandchild ○ Other relative ○ Stepson/stepdaughter If NOT RELATED to Person 1: ○ Roomer, boarder, or foster child ○ Unmarried partner ○ Housemate, roommate ○ Other nonrelative	If a RELATIVE of Person 1: ○ Husband/wife ○ Brother/sister ○ Natural-born or adopted son/daughter ○ Father/mother ○ Grandchild ○ Other relative ○ Stepson/stepdaughter If NOT RELATED to Person 1: ○ Roomer, boarder, or foster child ○ Unmarried partner ○ Housemate, roommate ○ Other nonrelative	If a RELATIVE of Person 1: ○ Husband/wife ○ Brother/sister ○ Natural-born or adopted son/daughter ○ Father/mother ○ Grandchild ○ Other relative ○ Stepson/stepdaughter If NOT RELATED to Person 1: ○ Roomer, boarder, or foster child ○ Unmarried partner ○ Housemate, roommate ○ Other nonrelative	If a RELATIVE of Person 1: ○ Husband/wife ○ Brother/sister ○ Natural-born or adopted son/daughter ○ Father/mother ○ Grandchild ○ Other relative ○ Stepson/stepdaughter If NOT RELATED to Person 1: ○ Roomer, boarder, or foster child ○ Unmarried partner ○ Housemate, roommate ○ Other nonrelative
○ Male ○ Female	○ Male ○ Female	○ Male ○ Female	○ Male ○ Female
○ White ○ Black or Negro ○ Indian (Amer.) (Print the na enrolled or principal tribe.) ○ Eskimo ○ Aleut Asian or Pacific Island ○ Chinese ○ Jap ○ Filipino ○ Asi ○ Hawaiian ○ Sa ○ Korean ○ Gu ○ Vietnamese ○ Oth ○ Other race (Print race)			Print the name of the cipal tribe.) cific Islander (API) ○ Japanese ○ Asian Indian ○ Samoan ○ Guamanian ○ Other API race)
a. Age b. Year of bi 1 0 ○ 0 ○ 0 ○ 1 ● 8 ○ 1 ○ 1 ○ 1 ○ 9 ○ 2 ○ 2 ○ 3 ○ 3 ○ 4 ○ 4 ○ 5 ○ 5 ○ 6 ○ 6 ○ 7 ○ 7 ○ 8 ○ 8 ○ 9 ○ 9 ○			Year of birth 1 ● 8 ○ 0 ○ 0 ○ 9 ○ 1 ○ 1 ○ 2 ○ 2 ○ 3 ○ 3 ○ 4 ○ 4 ○ 5 ○ 5 ○ 6 ○ 6 ○ 7 ○ 7 ○ 8 ○ 8 ○ 9 ○ 9 ○
○ Now married ○ Se ○ Widowed ○ Ne ○ Divorced			○ Separated ○ Never married
○ No (not Spanish/Hispanic) ○ Yes, Mexican, Mexican-Am ○ Yes, Puerto Rican ○ Yes, Cuban ○ Yes, other Spanish/Hispanic (Print one group, for example: Argentinean, Colombian, Dominican, Nicaraguan, Salvadoran, Spaniard, and so on.)	○ Yes, Cuban ○ Yes, other Spanish/Hispanic (Print one group, for example: Argentinean, Colombian, Dominican, Nicaraguan, Salvadoran, Spaniard, and so on.)	○ Yes, Cuban ○ Yes, other Spanish/Hispanic (Print one group, for example: Argentinean, Colombian, Dominican, Nicaraguan, Salvadoran, Spaniard, and so on.)	/Hispanic) exican-Am., Chicano ○ Yes, Cuban ○ Yes, other Spanish/Hispanic (Print one group, for example: Argentinean, Colombian, Dominican, Nicaraguan, Salvadoran, Spaniard, and so on.)
○ ○	○ ○	○ ○	○ ○

EXPLANATORY NOTES

This booklet shows the content of the two 1990 census questionnaires being delivered by mail. The content of these forms was determined after review of the 1980 census experience, extensive consultation with many government and private users of census data, and a series of experimental censuses and surveys in which various alternatives were tested.

Two principal types of data-collection forms — a 100-percent questionnaire (or "short form") and a sample questionnaire (or "long form") — are being used in the census. Each household receives one of the two questionnaires.

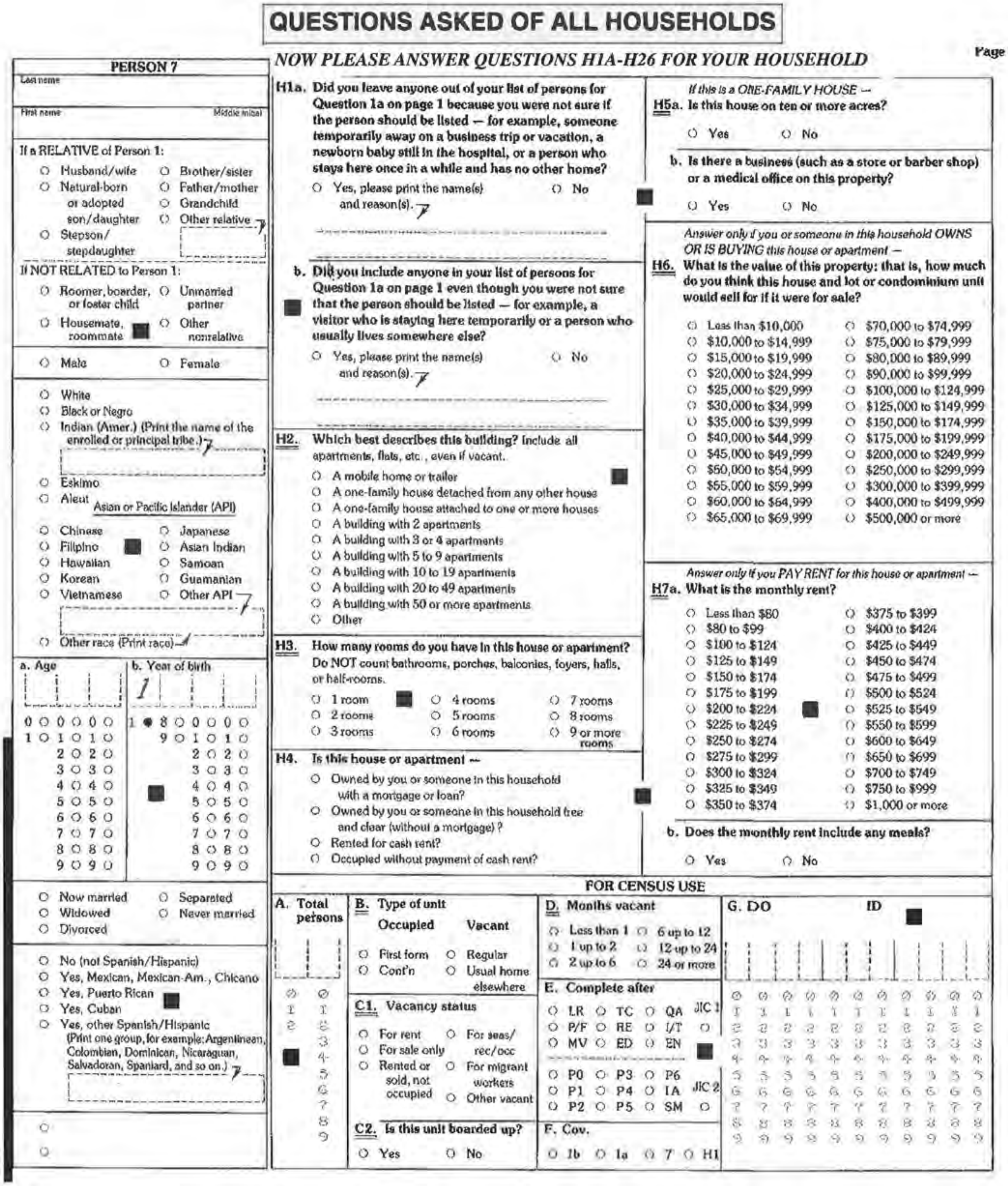
Short form — This questionnaire contains 7 population questions and 7 housing questions, shown on pages 1–3 of this booklet. On average, about 5 in every 6 households will receive the short form. For the average household, this form will take an estimated 14 minutes to complete.

Long form — This questionnaire has all of the short-form questions plus housing questions H8 through H26, shown on pages 4 and 5, and population questions 8 through 33, shown on pages 6 and 7. The population questions are repeated for each member of the household but these pages were not reproduced in this booklet. A statistical sample of approximately 1 in every 6 households will receive the long form. For the average household, this form will take an estimated 43 minutes to complete.

An instruction guide accompanies each questionnaire to help the respondents complete the form, and a preaddressed envelope is provided for returning the questionnaire.

For additional information about the 1990 U.S. Census, please write the Director, Bureau of the Census, Washington, DC 20233.

The 1990 Census Questionnaire



QUESTIONS ASKED OF ALL HOUSEHOLDS

NOW PLEASE ANSWER QUESTIONS H1A-H26 FOR YOUR HOUSEHOLD

Page 3

PERSON 7

Last name

First name Middle initial

If a RELATIVE of Person 1:
- ○ Husband/wife ○ Brother/sister
- ○ Natural-born or adopted son/daughter ○ Father/mother
- ○ Grandchild
- ○ Other relative
- ○ Stepson/stepdaughter

If NOT RELATED to Person 1:
- ○ Roomer, boarder, or foster child ○ Unmarried partner
- ○ Housemate, roommate ○ Other nonrelative

○ Male ○ Female

- ○ White
- ○ Black or Negro
- ○ Indian (Amer.) (Print the name of the enrolled or principal tribe.)
- ○ Eskimo
- ○ Aleut

Asian or Pacific Islander (API)
- ○ Chinese ○ Japanese
- ○ Filipino ○ Asian Indian
- ○ Hawaiian ○ Samoan
- ○ Korean ○ Guamanian
- ○ Vietnamese ○ Other API
- ○ Other race (Print race)

a. Age | b. Year of birth

a. Age		b. Year of birth		
○ 0 ○ 0	○ 0	1 ● 8 ○ 0	○ 0	○ 0
1 ○ 1	○ 1 ○	9 ○ 1	○ 1 ○	
2 ○ 2 ○		2 ○ 2 ○		
3 ○ 3 ○		3 ○ 3 ○		
4 ○ 4 ○		4 ○ 4 ○		
5 ○ 5 ○		5 ○ 5 ○		
6 ○ 6 ○		6 ○ 6 ○		
7 ○ 7 ○		7 ○ 7 ○		
8 ○ 8 ○		8 ○ 8 ○		
9 ○ 9 ○		9 ○ 9 ○		

- ○ Now married ○ Separated
- ○ Widowed ○ Never married
- ○ Divorced

- ○ No (not Spanish/Hispanic)
- ○ Yes, Mexican, Mexican-Am., Chicano
- ○ Yes, Puerto Rican
- ○ Yes, Cuban
- ○ Yes, other Spanish/Hispanic (Print one group, for example: Argentinean, Colombian, Dominican, Nicaraguan, Salvadoran, Spaniard, and so on.)

○

○

H1a. Did you leave anyone out of your list of persons for Question 1a on page 1 because you were not sure if the person should be listed — for example, someone temporarily away on a business trip or vacation, a newborn baby still in the hospital, or a person who stays here once in a while and has no other home?

○ Yes, please print the name(s) and reason(s). ○ No

b. Did you include anyone in your list of persons for Question 1a on page 1 even though you were not sure that the person should be listed — for example, a visitor who is staying here temporarily or a person who usually lives somewhere else?

○ Yes, please print the name(s) and reason(s). ○ No

H2. Which best describes this building? Include all apartments, flats, etc., even if vacant.
- ○ A mobile home or trailer
- ○ A one-family house detached from any other house
- ○ A one-family house attached to one or more houses
- ○ A building with 2 apartments
- ○ A building with 3 or 4 apartments
- ○ A building with 5 to 9 apartments
- ○ A building with 10 to 19 apartments
- ○ A building with 20 to 49 apartments
- ○ A building with 50 or more apartments
- ○ Other

H3. How many rooms do you have in this house or apartment? Do NOT count bathrooms, porches, balconies, foyers, halls, or half-rooms.

○ 1 room	○ 4 rooms	○ 7 rooms
○ 2 rooms	○ 5 rooms	○ 8 rooms
○ 3 rooms	○ 6 rooms	○ 9 or more rooms

H4. Is this house or apartment —
- ○ Owned by you or someone in this household with a mortgage or loan?
- ○ Owned by you or someone in this household free and clear (without a mortgage)?
- ○ Rented for cash rent?
- ○ Occupied without payment of cash rent?

If this is a ONE-FAMILY HOUSE —

H5a. Is this house on ten or more acres?

○ Yes ○ No

b. Is there a business (such as a store or barber shop) or a medical office on this property?

○ Yes ○ No

Answer only if you or someone in this household OWNS OR IS BUYING this house or apartment —

H6. What is the value of this property; that is, how much do you think this house and lot or condominium unit would sell for if it were for sale?

○ Less than $10,000	○ $70,000 to $74,999
○ $10,000 to $14,999	○ $75,000 to $79,999
○ $15,000 to $19,999	○ $80,000 to $89,999
○ $20,000 to $24,999	○ $90,000 to $99,999
○ $25,000 to $29,999	○ $100,000 to $124,999
○ $30,000 to $34,999	○ $125,000 to $149,999
○ $35,000 to $39,999	○ $150,000 to $174,999
○ $40,000 to $44,999	○ $175,000 to $199,999
○ $45,000 to $49,999	○ $200,000 to $249,999
○ $50,000 to $54,999	○ $250,000 to $299,999
○ $55,000 to $59,999	○ $300,000 to $399,999
○ $60,000 to $64,999	○ $400,000 to $499,999
○ $65,000 to $69,999	○ $500,000 or more

Answer only if you PAY RENT for this house or apartment —

H7a. What is the monthly rent?

○ Less than $80	○ $375 to $399
○ $80 to $99	○ $400 to $424
○ $100 to $124	○ $425 to $449
○ $125 to $149	○ $450 to $474
○ $150 to $174	○ $475 to $499
○ $175 to $199	○ $500 to $524
○ $200 to $224	○ $525 to $549
○ $225 to $249	○ $550 to $599
○ $250 to $274	○ $600 to $649
○ $275 to $299	○ $650 to $699
○ $300 to $324	○ $700 to $749
○ $325 to $349	○ $750 to $999
○ $350 to $374	○ $1,000 or more

b. Does the monthly rent include any meals?

○ Yes ○ No

FOR CENSUS USE

A. Total persons

0 1 2 3 4 5 6 7 8 9

B. Type of unit

Occupied	Vacant
○ First form	○ Regular
○ Cont'n	○ Usual home elsewhere

C1. Vacancy status
- ○ For rent ○ For seas/rec/occ
- ○ For sale only ○ For migrant workers
- ○ Rented or sold, not occupied ○ Other vacant

C2. Is this unit boarded up?

○ Yes ○ No

D. Months vacant
- ○ Less than 1 ○ 6 up to 12
- ○ 1 up to 2 ○ 12 up to 24
- ○ 2 up to 6 ○ 24 or more

E. Complete after

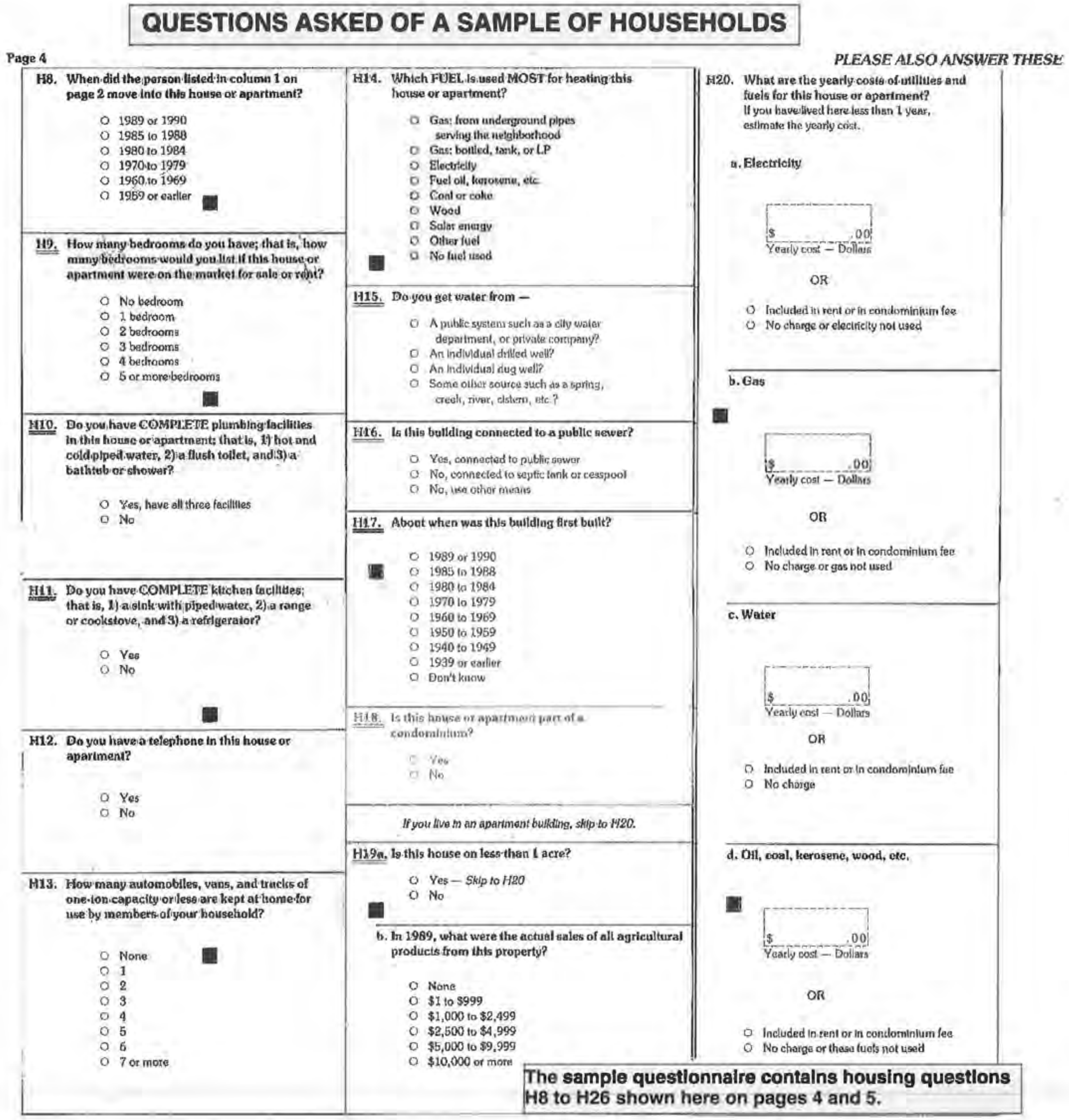
○ LR	○ TC	○ QA	JIC 1
○ P/F	○ RE	○ I/T	○
○ MV	○ ED	○ EN	
○ P0	○ P3	○ P6	
○ P1	○ P4	○ IA	JIC 2
○ P2	○ P5	○ SM	○

F. Cov.

○ 1b ○ 1a ○ 7 ○ H1

G. DO ID

0 1 2 3 4 5 6 7 8 9



QUESTIONS ASKED OF A SAMPLE OF HOUSEHOLDS

Page 4

PLEASE ALSO ANSWER THESE

H8. When did the person listed in column 1 on page 2 move into this house or apartment?

- ○ 1989 or 1990
- ○ 1985 to 1988
- ○ 1980 to 1984
- ○ 1970 to 1979
- ○ 1960 to 1969
- ○ 1959 or earlier

H9. How many bedrooms do you have; that is, how many bedrooms would you list if this house or apartment were on the market for sale or rent?

- ○ No bedroom
- ○ 1 bedroom
- ○ 2 bedrooms
- ○ 3 bedrooms
- ○ 4 bedrooms
- ○ 5 or more bedrooms

H10. Do you have COMPLETE plumbing facilities in this house or apartment; that is, 1) hot and cold piped water, 2) a flush toilet, and 3) a bathtub or shower?

- ○ Yes, have all three facilities
- ○ No

H11. Do you have COMPLETE kitchen facilities; that is, 1) a sink with piped water, 2) a range or cookstove, and 3) a refrigerator?

- ○ Yes
- ○ No

H12. Do you have a telephone in this house or apartment?

- ○ Yes
- ○ No

H13. How many automobiles, vans, and trucks of one-ton capacity or less are kept at home for use by members of your household?

- ○ None
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7 or more

H14. Which FUEL is used MOST for heating this house or apartment?

- ○ Gas: from underground pipes serving the neighborhood
- ○ Gas: bottled, tank, or LP
- ○ Electricity
- ○ Fuel oil, kerosene, etc.
- ○ Coal or coke
- ○ Wood
- ○ Solar energy
- ○ Other fuel
- ○ No fuel used

H15. Do you get water from —

- ○ A public system such as a city water department, or private company?
- ○ An individual drilled well?
- ○ An individual dug well?
- ○ Some other source such as a spring, creek, river, cistern, etc.?

H16. Is this building connected to a public sewer?

- ○ Yes, connected to public sewer
- ○ No, connected to septic tank or cesspool
- ○ No, use other means

H17. About when was this building first built?

- ○ 1989 or 1990
- ○ 1985 to 1988
- ○ 1980 to 1984
- ○ 1970 to 1979
- ○ 1960 to 1969
- ○ 1950 to 1959
- ○ 1940 to 1949
- ○ 1939 or earlier
- ○ Don't know

H18. Is this house or apartment part of a condominium?

- ○ Yes
- ○ No

If you live in an apartment building, skip to H20.

H19a. Is this house on less than 1 acre?

- ○ Yes — *Skip to H20*
- ○ No

b. In 1989, what were the actual sales of all agricultural products from this property?

- ○ None
- ○ $1 to $999
- ○ $1,000 to $2,499
- ○ $2,500 to $4,999
- ○ $5,000 to $9,999
- ○ $10,000 or more

H20. What are the yearly costs of utilities and fuels for this house or apartment?
If you have lived here less than 1 year, estimate the yearly cost.

a. Electricity

$ ______ .00
Yearly cost — Dollars

OR

- ○ Included in rent or in condominium fee
- ○ No charge or electricity not used

b. Gas

$ ______ .00
Yearly cost — Dollars

OR

- ○ Included in rent or in condominium fee
- ○ No charge or gas not used

c. Water

$ ______ .00
Yearly cost — Dollars

OR

- ○ Included in rent or in condominium fee
- ○ No charge

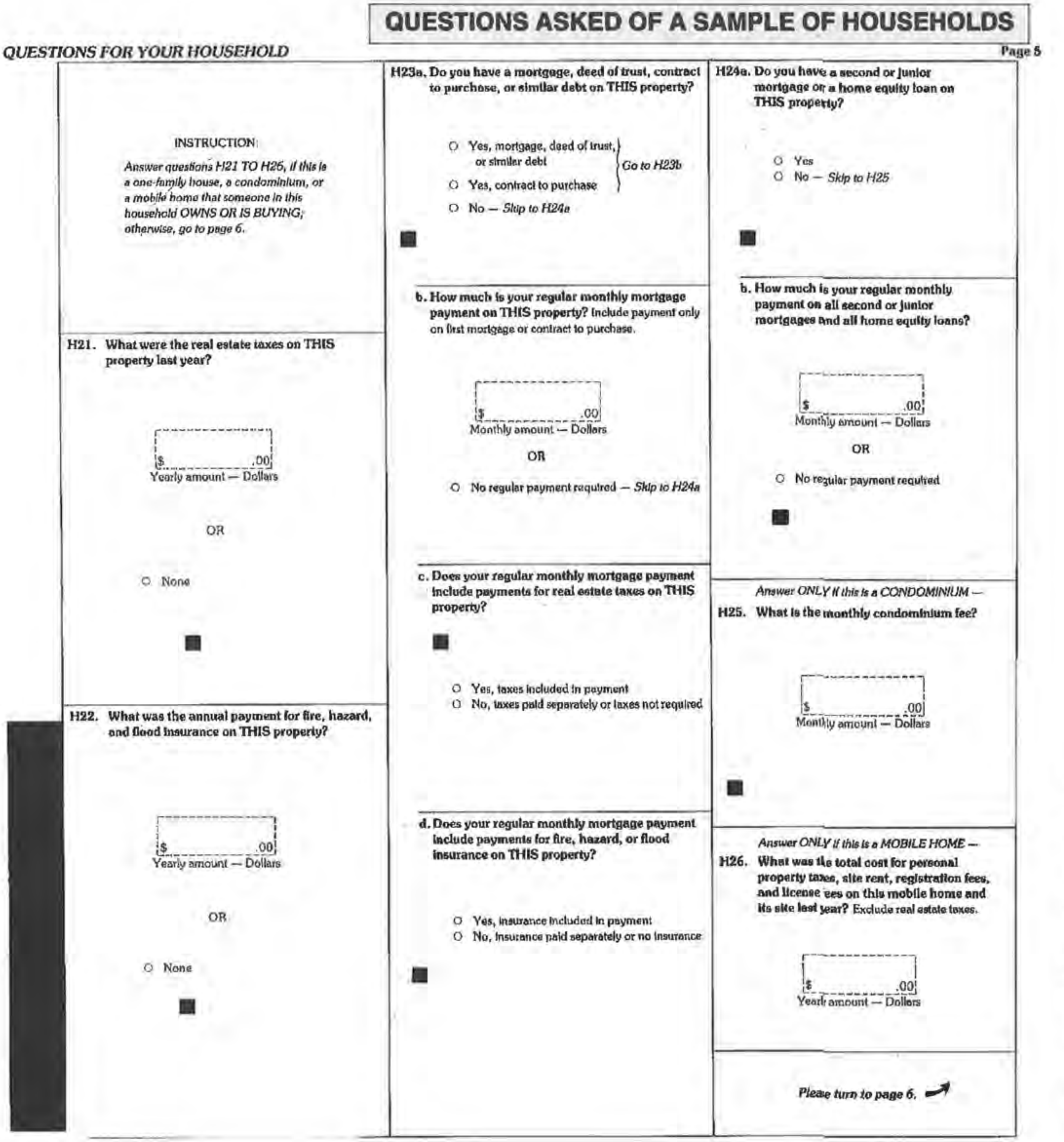
d. Oil, coal, kerosene, wood, etc.

$ ______ .00
Yearly cost — Dollars

OR

- ○ Included in rent or in condominium fee
- ○ No charge or these fuels not used

The sample questionnaire contains housing questions H8 to H26 shown here on pages 4 and 5.



QUESTIONS ASKED OF A SAMPLE OF HOUSEHOLDS

QUESTIONS FOR YOUR HOUSEHOLD

Page 5

INSTRUCTION:

Answer questions H21 TO H26, if this is a one-family house, a condominium, or a mobile home that someone in this household OWNS OR IS BUYING; otherwise, go to page 6.

H21. What were the real estate taxes on THIS property last year?

$ .00
Yearly amount — Dollars

OR

○ None

H22. What was the annual payment for fire, hazard, and flood insurance on THIS property?

$ .00
Yearly amount — Dollars

OR

○ None

H23a. Do you have a mortgage, deed of trust, contract to purchase, or similar debt on THIS property?

○ Yes, mortgage, deed of trust, or similar debt } *Go to H23b*
○ Yes, contract to purchase } *Go to H23b*
○ No — *Skip to H24a*

b. How much is your regular monthly mortgage payment on THIS property? Include payment only on first mortgage or contract to purchase.

$ .00
Monthly amount — Dollars

OR

○ No regular payment required — *Skip to H24a*

c. Does your regular monthly mortgage payment include payments for real estate taxes on THIS property?

○ Yes, taxes included in payment
○ No, taxes paid separately or taxes not required

d. Does your regular monthly mortgage payment include payments for fire, hazard, or flood insurance on THIS property?

○ Yes, insurance included in payment
○ No, insurance paid separately or no insurance

H24a. Do you have a second or junior mortgage or a home equity loan on THIS property?

○ Yes
○ No — *Skip to H25*

b. How much is your regular monthly payment on all second or junior mortgages and all home equity loans?

$ .00
Monthly amount — Dollars

OR

○ No regular payment required

Answer ONLY if this is a CONDOMINIUM —

H25. What is the monthly condominium fee?

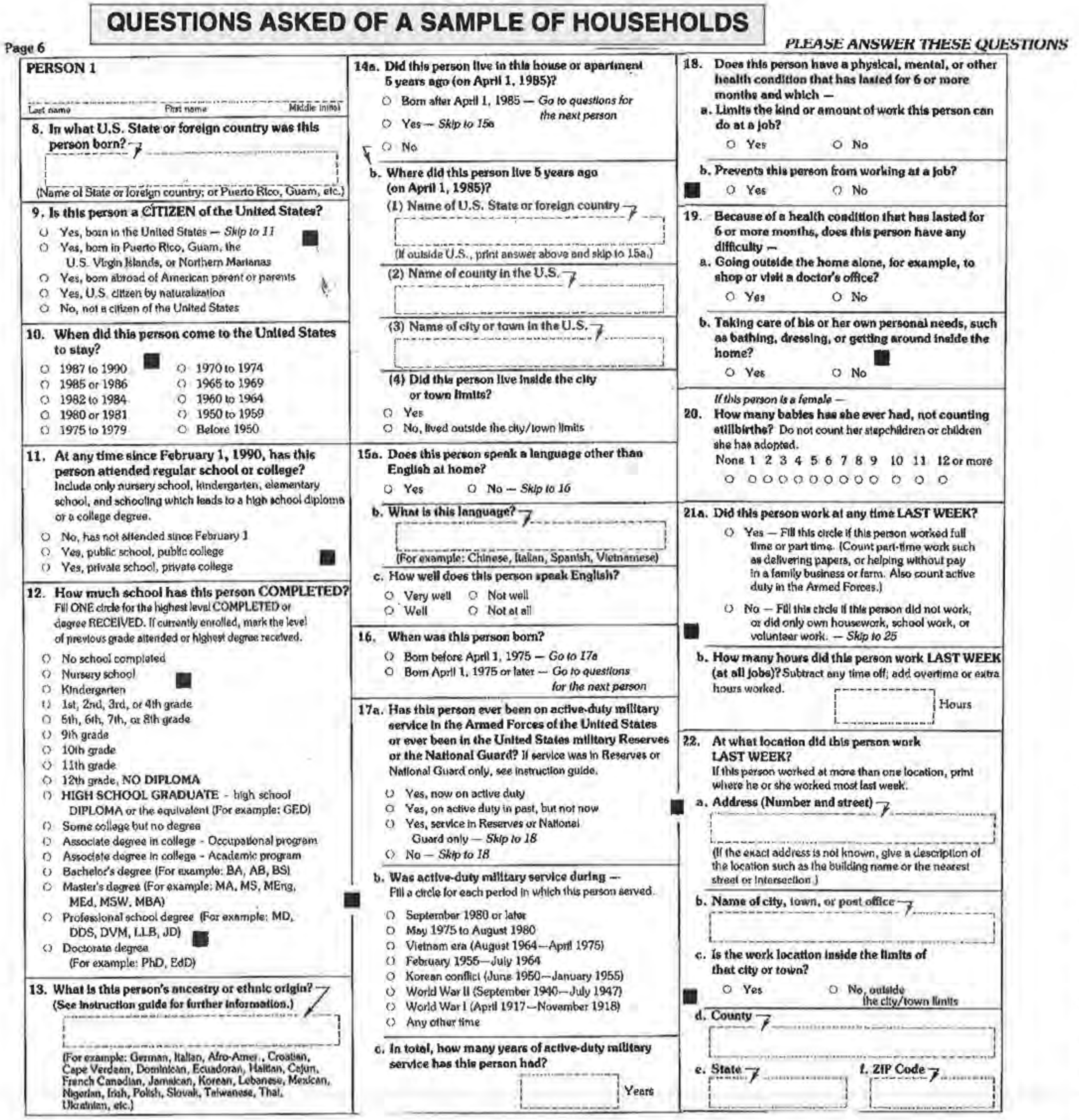
$ .00
Monthly amount — Dollars

Answer ONLY if this is a MOBILE HOME —

H26. What was the total cost for personal property taxes, site rent, registration fees, and license fees on this mobile home and its site last year? Exclude real estate taxes.

$ .00
Yearly amount — Dollars

Please turn to page 6.



QUESTIONS ASKED OF A SAMPLE OF HOUSEHOLDS

Page 6

PLEASE ANSWER THESE QUESTIONS

PERSON 1

Last name First name Middle initial

8. In what U.S. State or foreign country was this person born?

(Name of State or foreign country; or Puerto Rico, Guam, etc.)

9. Is this person a CITIZEN of the United States?

- ○ Yes, born in the United States — *Skip to 11*
- ○ Yes, born in Puerto Rico, Guam, the U.S. Virgin Islands, or Northern Marianas
- ○ Yes, born abroad of American parent or parents
- ○ Yes, U.S. citizen by naturalization
- ○ No, not a citizen of the United States

10. When did this person come to the United States to stay?

- ○ 1987 to 1990
- ○ 1985 or 1986
- ○ 1982 to 1984
- ○ 1980 or 1981
- ○ 1975 to 1979
- ○ 1970 to 1974
- ○ 1965 to 1969
- ○ 1960 to 1964
- ○ 1950 to 1959
- ○ Before 1950

11. At any time since February 1, 1990, has this person attended regular school or college? Include only nursery school, kindergarten, elementary school, and schooling which leads to a high school diploma or a college degree.

- ○ No, has not attended since February 1
- ○ Yes, public school, public college
- ○ Yes, private school, private college

12. How much school has this person COMPLETED? Fill ONE circle for the highest level COMPLETED or degree RECEIVED. If currently enrolled, mark the level of previous grade attended or highest degree received.

- ○ No school completed
- ○ Nursery school
- ○ Kindergarten
- ○ 1st, 2nd, 3rd, or 4th grade
- ○ 5th, 6th, 7th, or 8th grade
- ○ 9th grade
- ○ 10th grade
- ○ 11th grade
- ○ 12th grade, NO DIPLOMA
- ○ HIGH SCHOOL GRADUATE - high school DIPLOMA or the equivalent (For example: GED)
- ○ Some college but no degree
- ○ Associate degree in college - Occupational program
- ○ Associate degree in college - Academic program
- ○ Bachelor's degree (For example: BA, AB, BS)
- ○ Master's degree (For example: MA, MS, MEng, MEd, MSW, MBA)
- ○ Professional school degree (For example: MD, DDS, DVM, LLB, JD)
- ○ Doctorate degree (For example: PhD, EdD)

13. What is this person's ancestry or ethnic origin? (See instruction guide for further information.)

(For example: German, Italian, Afro-Amer., Croatian, Cape Verdean, Dominican, Ecuadoran, Haitian, Cajun, French Canadian, Jamaican, Korean, Lebanese, Mexican, Nigerian, Irish, Polish, Slovak, Taiwanese, Thai, Ukrainian, etc.)

14a. Did this person live in this house or apartment 5 years ago (on April 1, 1985)?

- ○ Born after April 1, 1985 — *Go to questions for the next person*
- ○ Yes — *Skip to 15a*
- ○ No

b. Where did this person live 5 years ago (on April 1, 1985)?

(1) Name of U.S. State or foreign country

(If outside U.S., print answer above and skip to 15a.)

(2) Name of county in the U.S.

(3) Name of city or town in the U.S.

(4) Did this person live inside the city or town limits?

- ○ Yes
- ○ No, lived outside the city/town limits

15a. Does this person speak a language other than English at home?

○ Yes ○ No — *Skip to 16*

b. What is this language?

(For example: Chinese, Italian, Spanish, Vietnamese)

c. How well does this person speak English?

- ○ Very well
- ○ Well
- ○ Not well
- ○ Not at all

16. When was this person born?

- ○ Born before April 1, 1975 — *Go to 17a*
- ○ Born April 1, 1975 or later — *Go to questions for the next person*

17a. Has this person ever been on active-duty military service in the Armed Forces of the United States or ever been in the United States military Reserves or the National Guard? If service was in Reserves or National Guard only, see instruction guide.

- ○ Yes, now on active duty
- ○ Yes, on active duty in past, but not now
- ○ Yes, service in Reserves or National Guard only — *Skip to 18*
- ○ No — *Skip to 18*

b. Was active-duty military service during — Fill a circle for each period in which this person served.

- ○ September 1980 or later
- ○ May 1975 to August 1980
- ○ Vietnam era (August 1964—April 1975)
- ○ February 1955—July 1964
- ○ Korean conflict (June 1950—January 1955)
- ○ World War II (September 1940—July 1947)
- ○ World War I (April 1917—November 1918)
- ○ Any other time

c. In total, how many years of active-duty military service has this person had?

Years

18. Does this person have a physical, mental, or other health condition that has lasted for 6 or more months and which —

a. Limits the kind or amount of work this person can do at a job?

○ Yes ○ No

b. Prevents this person from working at a job?

○ Yes ○ No

19. Because of a health condition that has lasted for 6 or more months, does this person have any difficulty —

a. Going outside the home alone, for example, to shop or visit a doctor's office?

○ Yes ○ No

b. Taking care of his or her own personal needs, such as bathing, dressing, or getting around inside the home?

○ Yes ○ No

If this person is a female —

20. How many babies has she ever had, not counting stillbirths? Do not count her stepchildren or children she has adopted.

None	1	2	3	4	5	6	7	8	9	10	11	12 or more
○	○	○	○	○	○	○	○	○	○	○	○	○

21a. Did this person work at any time LAST WEEK?

- ○ Yes — Fill this circle if this person worked full time or part time. (Count part-time work such as delivering papers, or helping without pay in a family business or farm. Also count active duty in the Armed Forces.)
- ○ No — Fill this circle if this person did not work, or did only own housework, school work, or volunteer work. — *Skip to 25*

b. How many hours did this person work LAST WEEK (at all jobs)? Subtract any time off; add overtime or extra hours worked.

Hours

22. At what location did this person work LAST WEEK?
If this person worked at more than one location, print where he or she worked most last week.

a. Address (Number and street)

(If the exact address is not known, give a description of the location such as the building name or the nearest street or intersection.)

b. Name of city, town, or post office

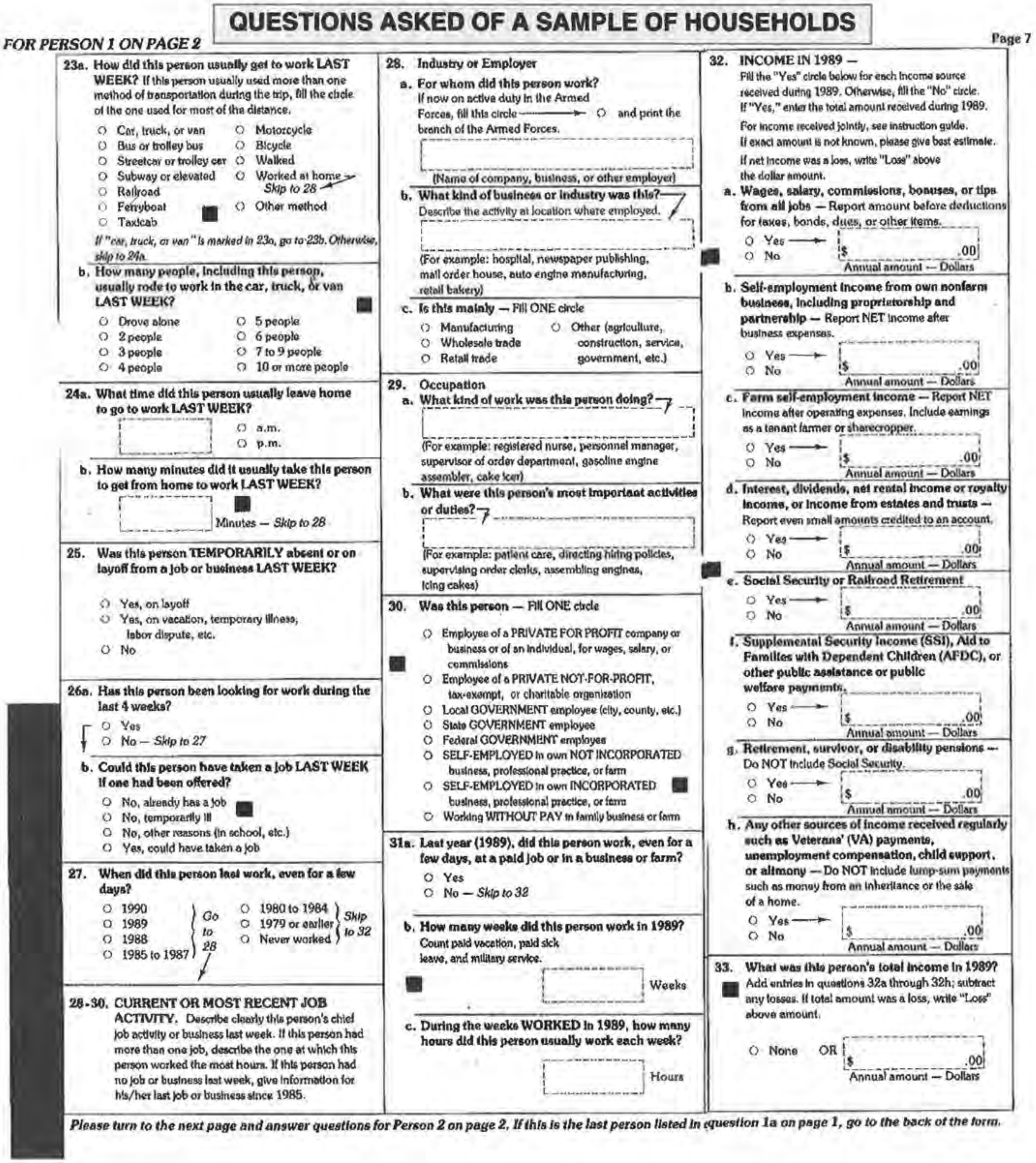
c. Is the work location inside the limits of that city or town?

○ Yes ○ No, outside the city/town limits

d. County

e. State

f. ZIP Code



QUESTIONS ASKED OF A SAMPLE OF HOUSEHOLDS

FOR PERSON 1 ON PAGE 2

Page 7

23a. How did this person usually get to work LAST WEEK? If this person usually used more than one method of transportation during the trip, fill the circle of the one used for most of the distance.

○ Car, truck, or van
○ Bus or trolley bus
○ Streetcar or trolley car
○ Subway or elevated
○ Railroad
○ Ferryboat
○ Taxicab
○ Motorcycle
○ Bicycle
○ Walked
○ Worked at home → *Skip to 28*
○ Other method

If "car, truck, or van" is marked in 23a, go to 23b. Otherwise, skip to 24a.

b. How many people, including this person, usually rode to work in the car, truck, or van LAST WEEK?

○ Drove alone
○ 2 people
○ 3 people
○ 4 people
○ 5 people
○ 6 people
○ 7 to 9 people
○ 10 or more people

24a. What time did this person usually leave home to go to work LAST WEEK?

○ a.m.
○ p.m.

b. How many minutes did it usually take this person to get from home to work LAST WEEK?

Minutes — *Skip to 28*

25. Was this person TEMPORARILY absent or on layoff from a job or business LAST WEEK?

○ Yes, on layoff
○ Yes, on vacation, temporary illness, labor dispute, etc.
○ No

26a. Has this person been looking for work during the last 4 weeks?

○ Yes
○ No — *Skip to 27*

b. Could this person have taken a job LAST WEEK if one had been offered?

○ No, already has a job
○ No, temporarily ill
○ No, other reasons (in school, etc.)
○ Yes, could have taken a job

27. When did this person last work, even for a few days?

○ 1990
○ 1989
○ 1988
○ 1985 to 1987
Go to 28

○ 1980 to 1984
○ 1979 or earlier
○ Never worked
Skip to 32

28-30. CURRENT OR MOST RECENT JOB ACTIVITY. Describe clearly this person's chief job activity or business last week. If this person had more than one job, describe the one at which this person worked the most hours. If this person had no job or business last week, give information for his/her last job or business since 1985.

28. Industry or Employer

a. For whom did this person work? If now on active duty in the Armed Forces, fill this circle → ○ and print the branch of the Armed Forces.

(Name of company, business, or other employer)

b. What kind of business or industry was this? Describe the activity at location where employed.

(For example: hospital, newspaper publishing, mail order house, auto engine manufacturing, retail bakery)

c. Is this mainly — Fill ONE circle

○ Manufacturing
○ Wholesale trade
○ Retail trade
○ Other (agriculture, construction, service, government, etc.)

29. Occupation

a. What kind of work was this person doing?

(For example: registered nurse, personnel manager, supervisor of order department, gasoline engine assembler, cake icer)

b. What were this person's most important activities or duties?

(For example: patient care, directing hiring policies, supervising order clerks, assembling engines, icing cakes)

30. Was this person — Fill ONE circle

○ Employee of a PRIVATE FOR PROFIT company or business or of an individual, for wages, salary, or commissions
○ Employee of a PRIVATE NOT-FOR-PROFIT, tax-exempt, or charitable organization
○ Local GOVERNMENT employee (city, county, etc.)
○ State GOVERNMENT employee
○ Federal GOVERNMENT employee
○ SELF-EMPLOYED in own NOT INCORPORATED business, professional practice, or farm
○ SELF-EMPLOYED in own INCORPORATED business, professional practice, or farm
○ Working WITHOUT PAY in family business or farm

31a. Last year (1989), did this person work, even for a few days, at a paid job or in a business or farm?

○ Yes
○ No — *Skip to 32*

b. How many weeks did this person work in 1989? Count paid vacation, paid sick leave, and military service.

Weeks

c. During the weeks WORKED in 1989, how many hours did this person usually work each week?

Hours

32. INCOME IN 1989 —

Fill the "Yes" circle below for each income source received during 1989. Otherwise, fill the "No" circle. If "Yes," enter the total amount received during 1989.

For income received jointly, see instruction guide. If exact amount is not known, please give best estimate.

If net income was a loss, write "Loss" above the dollar amount.

a. Wages, salary, commissions, bonuses, or tips from all jobs — Report amount before deductions for taxes, bonds, dues, or other items.

○ Yes →
○ No
$ .00
Annual amount — Dollars

b. Self-employment income from own nonfarm business, including proprietorship and partnership — Report NET income after business expenses.

○ Yes →
○ No
$ .00
Annual amount — Dollars

c. Farm self-employment income — Report NET income after operating expenses. Include earnings as a tenant farmer or sharecropper.

○ Yes →
○ No
$ .00
Annual amount — Dollars

d. Interest, dividends, net rental income or royalty income, or income from estates and trusts — Report even small amounts credited to an account.

○ Yes →
○ No
$ .00
Annual amount — Dollars

e. Social Security or Railroad Retirement

○ Yes →
○ No
$ .00
Annual amount — Dollars

f. Supplemental Security Income (SSI), Aid to Families with Dependent Children (AFDC), or other public assistance or public welfare payments.

○ Yes →
○ No
$ .00
Annual amount — Dollars

g. Retirement, survivor, or disability pensions — Do NOT include Social Security.

○ Yes →
○ No
$ .00
Annual amount — Dollars

h. Any other sources of income received regularly such as Veterans' (VA) payments, unemployment compensation, child support, or alimony — Do NOT include lump-sum payments such as money from an inheritance or the sale of a home.

○ Yes →
○ No
$ .00
Annual amount — Dollars

33. What was this person's total income in 1989? Add entries in questions 32a through 32h; subtract any losses. If total amount was a loss, write "Loss" above amount.

○ None OR $ .00
Annual amount — Dollars

Please turn to the next page and answer questions for Person 2 on page 2. If this is the last person listed in question 1a on page 1, go to the back of the form.

Page 8

Please make sure you have . . .

1. **FILLED this form completely.**
2. **ANSWERED Question 1a** on page 1.
3. **ANSWERED Questions 2 through 7** for each person you listed in Question 1a.
4. **ANSWERED Questions H1a through H26** on pages 3, 4, and 5.
5. **ANSWERED the questions on pages 6 through 19** for each person you listed in Question 1a.

Also . . .

6. **PRINT here the name** of a household member who filled the form, the date the form was completed, and the telephone number at which a person in this household can be called.

Name			Date
Telephone number →	Area code	Number	○ Day ○ Night

Then . . .

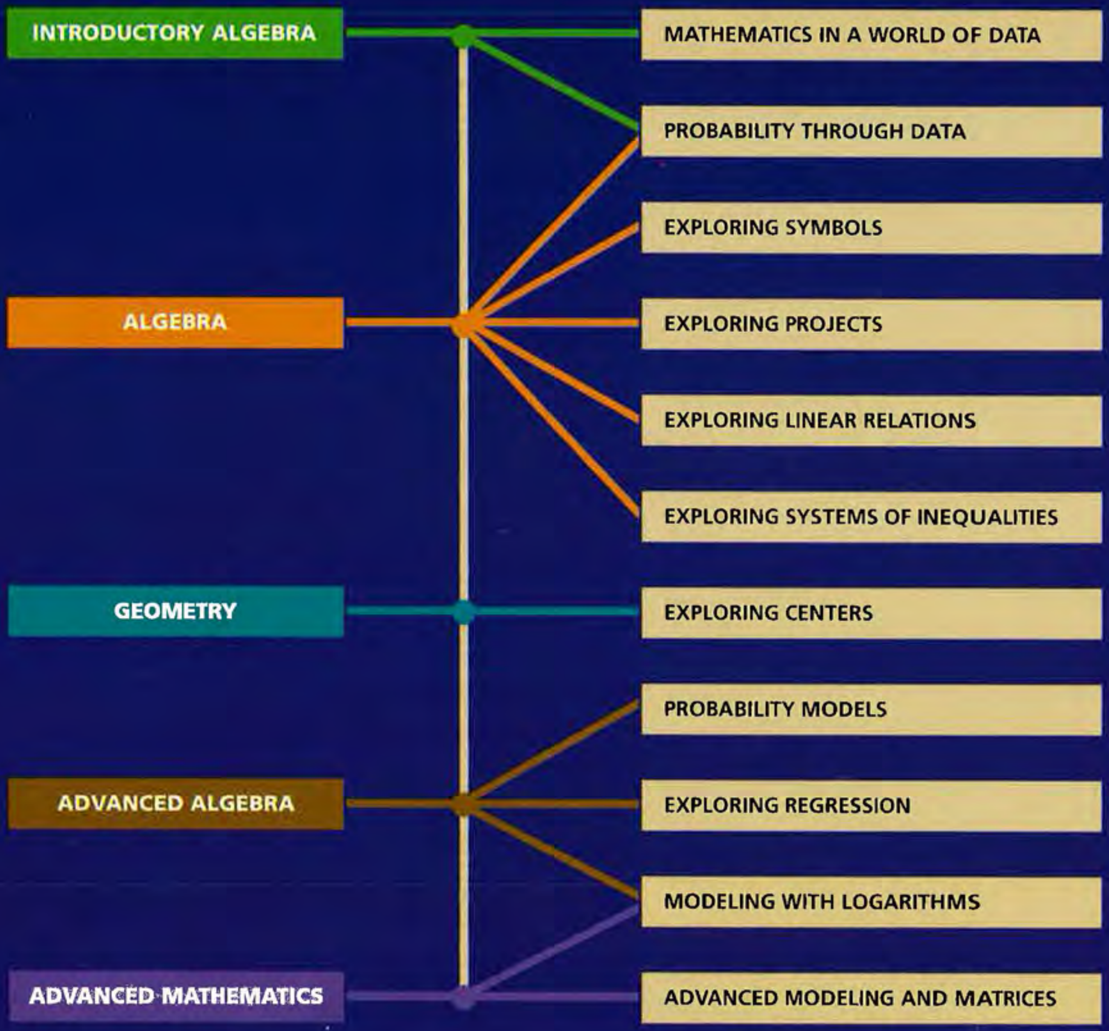
7. **FOLD the form the way it was sent to you.**
8. **MAIL it back by April 1**, or as close to that date as possible, in the envelope provided; no stamp is needed. When you insert your completed questionnaire, please make sure that the address of the U.S. Census office can be seen through the window on the front of the envelope.

NOTE – If you have listed more than 7 persons in Question 1a, please make sure that you have filled the form for the first 7 people. Then mail back this form. A census taker will call to obtain the information on the other people.

Thank you very much.

NOTES

Data-Driven Mathematics is a series of modules written by teachers and statisticians that focuses on the use of real data and statistics to motivate traditional mathematics topics. This chart suggests which modules could be used to supplement specific middle-school and high-school mathematics courses.



Dale Seymour Publications® is a leading publisher of K–12 educational materials in mathematics, thinking skills, science, language arts, and art education.

90000
9 781572 323988
ISBN 1-57232-398-1
21165

DALE
SEYMOUR
PUBLICATIONS®