How to Design and Evaluate Research in Education

Ninth Edition

Jack R. Fraenkel | Norman E. Wallen | Helen H. Hyun

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Mc Graw Hill Education

HOW TO DESIGN AND EVALUATE RESEARCH IN EDUCATION, NINTH EDITION

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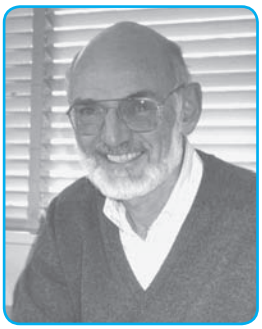

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To Marge, Lina, and Jeff for all their support

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PREFACE

How to Design and Evaluate Research in Education is directed to students taking their first course in educational research. Because this field continues to grow so rapidly with regard to both the knowledge it contains and the methodologies it employs, the authors of any introductory text are forced to carefully define their goals as a first step in deciding what to include in their book. In our case, we continually kept three main goals in mind. We wanted to produce a text that would:

1. Provide students with the basic information needed to understand the research process, from idea formulation through data analysis and interpretation.
2. Enable students to use this knowledge to design their own research investigation on a topic of personal interest.
3. Permit students to read and understand the literature of educational research.

The first two goals are intended to satisfy the needs of those students who must plan and carry out a research project as part of their course requirements. The third goal is aimed at students whose course requirements include learning how to read and understand the research of others. Many instructors, ourselves included, build all three goals into their courses, since each one seems to reinforce the others. It is hard to read and fully comprehend the research of others if you have not yourself gone through the process of designing and evaluating a research project. Similarly, the more you read and evaluate the research of others, the better equipped you will be to design your own meaningful and creative research. In order to achieve the above goals, we have developed a book with the following characteristics.

CONTENT COVERAGE

Goal one, to provide students with the basic information needed to understand the research process, has resulted in a nine-part book plan. Part 1 (Chapter 1) introduces students to the nature of educational research, briefly overviews each of the seven methodologies discussed later in the text, and presents an overview of the research process as well as criticisms of it.

Part 2 (Chapters 2 through 9) discusses the basic concepts and procedures that must be understood before one can engage in research intelligently or critique it meaningfully. These chapters explain variables, definitions, ethics, sampling, instrumentation, validity, reliability, and internal validity. These and other concepts are covered thoroughly, clearly, and relatively simply. Our emphasis throughout is to show students, by means of clear and appropriate examples, how to set up a research study in an educational setting on a question of interest and importance.

Part 3 (Chapters 10 through 12) describes in some detail the processes involved in collecting and analyzing data.

Part 4 (Chapters 13 through 17) describes and illustrates the methodologies most commonly used in quantitative educational research. Many key concepts presented in Part 2 are considered again in these chapters in order to illustrate their application to each methodology. Finally, each methodology chapter concludes with a carefully chosen study from the published research literature. Each study is analyzed by the authors with regard to both its strengths and weaknesses. Students are shown how to read and critically analyze a study they might find in the literature.

Part 5 (Chapters 18 through 20) and Part 6 (Chapters 21 through 22) discuss qualitative research. Part 5 begins the coverage by describing qualitative research, its philosophy, and essential features. It has been expanded to include various types of qualitative research. This is followed by an expanded treatment of both data collection and analysis methods. Part 6 presents the qualitative methodologies of ethnography and historical research. As with the quantitative methodology chapters, all but one of these is followed by a carefully chosen research report from the published research literature, along with our analysis and critique.

Part 7 (Chapter 23) discusses Mixed-Methods Studies, which combine quantitative and qualitative methods. Again, as in other chapters, the discussion is followed by our analysis and critique of a research report we have chosen from the published research literature.

Part 8 (Chapter 24) describes the assumptions, characteristics, and steps of action research. Classroom examples of action research questions bring the subject to life, as does the addition of a critique of a published study.

Part 9 (Chapter 25) shows how to prepare a research proposal or report (involving a methodology of choice) that builds on the concepts and examples developed and illustrated in previous chapters.

RESEARCH EXERCISES

To achieve our second goal of helping students learn to apply their knowledge of basic processes and methodologies, we organized the first 12 chapters in the same order that students normally follow in developing a research proposal or conducting a research project. Then we concluded each of these chapters with a research exercise that includes a fill-in problem sheet. These exercises allow students to apply their understanding of the major concepts of each chapter. When completed, these accumulated problem sheets will have led students through the step-by-step processes involved in designing their own research projects. Although this step-by-step development requires some revision of their work as they learn more about the research process, the gain in understanding that results as they slowly see their proposal develop "before their eyes" justifies the extra time and effort involved.

Problem Sheet templates are available electronically at the Online Learning Center Web site, www.mhhe.com/fraenkel9e.

ACTUAL RESEARCH STUDIES

Our third goal, to enable students to read and understand the literature of educational research, has led us to conclude each of the methodology chapters in Parts 4, 5, 6, 7, and 8, with an annotated study that illustrates a particular research method. At the end of each study we analyze its strengths and weaknesses and offer suggestions as to how it might be improved. Similarly, at the end of our chapter on writing research proposals and reports, we include a student research proposal that we have critiqued with marginal comments. This annotated proposal has proved an effective means of helping students understand both sound and questionable research practices.

STYLE OF PRESENTATION

Because students are typically anxious regarding the content of research courses, we have taken extraordinary care not to overwhelm them with dry, abstract discussions, and we have adopted an informal writing style. More than in any text to date, our presentations are laced with clarifying examples and with summarizing charts, tables, and diagrams. Our experience in teaching research courses for more than 30 years has convinced us that there is no such thing as having "too many" examples in a basic text.

In addition to the many examples and illustrations that are embedded in the text, we have built the following pedagogical features into the book: (1) a graphic organizer for each chapter, (2) chapter objectives, (3) chapter-opening examples, (4) end-of-chapter summaries, (5) key terms with page references, (6) discussion questions, and (7) an extensive end-of-book glossary.

CHANGES IN THE NINTH EDITION

A number of key additions, new illustrations, and improved or refined examples, terminology, and definitions have been incorporated in this edition to further meet the goals of the text. The References have been updated throughout to include the latest research and

have been reformatted to reflect use of APA style, Research Exercises and Problem Sheets have been revised with more effective questions.

Following is a sampling of chapter-by-chapter changes:

Chapter 1: The Nature of Educational Research
- New discussion on education research in the digital age

Chapter 3: Locating and Reviewing the Literature
- How to annotate sources prior to preparation of a literature review
- New example of an annotated bibliography in tabular form
- Updated screen shots of ERIC and other useful databases
- Updated image and text for acquiring survey results
- Tips for avoiding plagiarism when summarizing sources
- New set of prompts for evaluating published sources
- New section on academic style manuals (e.g., APA) with links to website and online tutorials

Chapter 4: Ethics and Research
- New information about online plagiarism checking tools
- Updated More About Research box with the latest Department of Health and Human Services regulations for research with human subjects

Chapter 5: Variables and Hypotheses
- New information on using propositions in qualitative research

Chapter 6: Sampling
- New material on "transferability" and how generalizing can be enhanced in qualitative studies

Chapter 7: Instrumentation
- New content on the use of data collection tools in qualitative research

Chapter 14: Single-Subject Research
- New annotated Research Report and Analysis on the effects of guiding reading with deaf students

Chapter 15: Correlational Research
- New annotated Research Report and Analysis on the features and correlations between teaching behaviors and learning activities in urban high school physical education

Chapter 17: Survey Research
- New information on polls and polling
- Discussion of SurveyMonkey and Qualtrics, the web-based survey tools most commonly used by academic institutions
- New annotated Research Report and Analysis on teaching secondary social studies

Chapter 24: Action Research
- New information on reflective practice in teacher research using self-study

New Annotated and Analyzed Research Reports: Three new Research Reports have been added to the text, introducing more research involving qualitative research as well as urban and secondary settings, helping the student apply the text's concepts and also practice evaluating published studies.

- Implementation of the Guided Reading Approach with Elementary School Deaf Students
- Physical Education in Urban High School Class Settings: Features and Correlations Between Teaching Behaviors and Learning Activities
- Teaching Social Studies in the 21st Century: A Research Study of Secondary Social Studies Teachers Instructional Methods and Practices

SPECIAL FEATURES

Support for Student Learning

How to Design and Evaluate Research in Education helps students become critical consumers of research and prepares them to conduct and report their own research.

Chapter-opening Features: Each chapter begins with an illustration that visually introduces a topic or issues related to the chapter. This is followed by an outline of chapter content, chapter learning objectives, the *Interactive and Applied Learning* feature that lists related supplementary material, and a related vignette.

More About Research, Research Tips,* and *Controversies in Research: These informative sections help students to think critically about research while illustrating important techniques in educational research.

End-of-Chapter Learning Supports: The chapters conclude with a reminder of the supplementary resources available, a detailed Main Points section, a listing of Key Terms, and Questions for Discussion.

Chapters 1–12 include a **Research Exercise** and a **Problem Sheet** to aid students in the construction of a research project.

Chapters 13–17 and 19–24 include an actual **Research Report** that has been annotated to highlight concepts discussed in the chapter.

Practical Resources and Examples for Doing and Reading Research

How to Design and Evaluate Research in Education provides a comprehensive introduction to research that is brought to life through practical resources and examples for doing and reading research.

- ***Research Tips* boxes** provide practical suggestions for doing research.
- The **Annotated Research Reports** at the conclusion of Chapters 13–17 and 19–24 present students with research reports and author commentary on how the study authors have approached and supported their research.
- **Research Exercises** and **Problems Sheets** at the conclusion of Chapters 1–13 are tools for students to use when creating their own research projects.
- ***Using Excel* boxes** show how these software programs can be used to calculate various statistics.
- Chapter 24: ***Action Research*** details how classroom teachers can and should do research to improve their teaching.
- Chapter 25: ***Preparing Research Proposals and Reports*** walks the reader through proposal and report preparation.
- **Resources on the Online Learning Center Web site** (see listing below) provide students with a place to start when gathering research tools.

SUPPLEMENTS THAT SUPPORT STUDENT LEARNING

Online Learning Center Web Site at www.mhhe.com/fraenkel9e

The Online Learning Center Web site offers tools for study, practice, and application including:

Study Resources

- Multiple quizzes and flashcards for testing content knowledge

Practice Resources

- Student Mastery Activities that provide students extra practice with specific concepts
- Data Analysis Examples and Exercises

Research Resources

- Statistics Program
- Correlation Coefficient Applet
- Chi Square Applet
- Research Wizard, a wizard version of the Problem Sheets
- Forms, including a Research Worksheet, Sample Consent Forms, Research Checklists, electronic versions of the Problem Sheets
- A Listing of Professional Journals
- *Bibliography Builder,* an electronic reference builder
- The McGraw-Hill Guide to Electronic Research

SUPPLEMENTS THAT SUPPORT INSTRUCTORS

Online Learning Center Web Site at www.mhhe.com/fraenkel9e

The Instructor's portion of the Online Learning Center offers a number of useful resources for classroom instruction, including an Instructor's Manual, Test Bank, Computerized Test Bank, chapter-by-chapter PowerPoint presentations, and additional resources.

ACKNOWLEDGMENTS

Directly and indirectly, many people have contributed to the preparation of this text. We will begin by acknowledging the students in our research classes, who, over the years, have taught us much. Also, we wish to thank the reviewers of this edition, whose generous comments have guided the preparation of this edition. They include:

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Graham Stead, Cleveland State University
Andrew Topper, Grand Valley State University
Brenda Walling, East Central University

We would also like to thank Vicki Malinee of Van Brien and Associates and the editors and staff at McGraw-Hill for their efforts in turning the manuscript into the finished book before you.

Finally, we would like to thank our spouses for their unflagging support during the highs and lows that inevitably accompany the preparation of a text of this magnitude.

Jack R. Fraenkel
Norman E. Wallen
Helen H. Hyun

A Guided Tour of
How to Design and Evaluate Research in Education

Welcome to *How to Design and Evaluate Research in Education*.

This comprehensive introduction to research methods was designed to present the basics of educational research in as interesting and understandable a way as possible. To accomplish this, we've created the following features for each chapter.

Opening Illustration

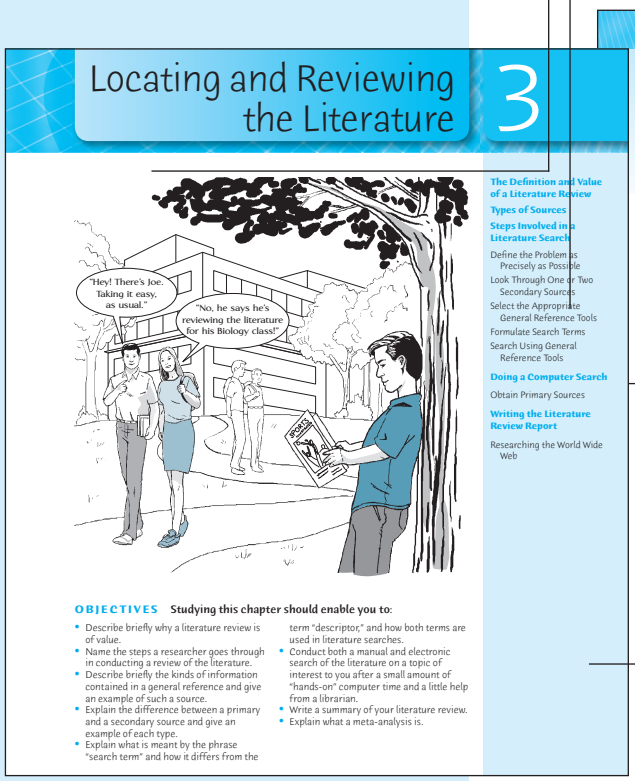
Each chapter opens with an illustrative depiction of a key concept that will be covered in the chapter.

Chapter Outline

Next, a chapter outline lists the topics to follow.

Interactive and Applied Learning Tools

This special feature lists the practice activities and resources related to the chapter that are available in the student supplements.



Locating and Reviewing the Literature 3

OBJECTIVES **Studying this chapter should enable you to:**

- Describe briefly why a literature review is of value.
- Name the steps a researcher goes through in conducting a review of the literature.
- Describe briefly the kinds of information contained in a general reference and give an example of such a source.
- Explain the difference between a primary and a secondary source and give an example of each type.
- Explain what is meant by the phrase "search term" and how it differs from the term "descriptor," and how both terms are used in literature searches.
- Conduct both a manual and electronic search of the literature on a topic of interest to you after a small amount of "hands-on" computer time and a little help from a librarian.
- Write a summary of your literature review.
- Explain what a meta-analysis is.

INTERACTIVE AND APPLIED LEARNING After, or while, reading this chapter:

Go to the Online Learning Center at www.mhhe.com/fraenkel9e to:

- Read the Guide to Electronic Research

Go to your online Student Mastery Activities book to do the following activities:

- Activity 3.1: Library Worksheet
- Activity 3.2: Where Would You Look?
- Activity 3.3: Do a Computer Search of the Literature

After a career in the military, Phil Gomez is in his first year as a teacher at an adult school in Logan, Utah. He teaches U.S. history to students who did not graduate from high school but who now are trying to obtain a diploma. He has learned the hard way, through trial and error, that there are a number of techniques that simply put students to sleep. He sincerely wants to be a good teacher, but he is having trouble getting his students interested in the subject. As he is the only history teacher in the school, the other teachers are not of much help.

He wants to get some ideas, therefore, about other approaches, strategies, and techniques that he might use. He decides to do an Internet search to see what he can find out about effective strategies for teaching high school history. His first search yields 12,847 hits! Phil is overwhelmed and at a loss for which sources to view. Should he look at books? Journal articles? Websites? Government documents? Unpublished reports? Where should he look for the most valid resources? And how could his searching be done more systematically?

Chapter-Opening Example

The chapter text begins with a practical example—a dialogue between researchers or a peek into a classroom—related to the content to follow.

Objectives

Chapter objectives prepare the student for the chapter ahead.

MORE ABOUT RESEARCH

Department of Health and Human Services Revised Regulations for Research with Human Subjects

The following HHS guidelines currently allow for exemption from IRB review for certain projects. However, please make sure to check with your IRB for their exempt research guidelines.

1. Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.
2. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.
3. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) require(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.
4. Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.
5. Research and demonstration projects which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) Public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.
6. Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the Food and Drug Administration or approved by the Environmental Protection Agency or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

U.S. Department of Health and Human Services, 45CFR 46.101(b)(1)–(6).

Research activities involving human subjects that are **exempt** from IRB review are identified in 45CFR 46.101(b)(1)–(6). (Institutions and IRBs may not create new categories of exempt research under 45 CFR Part 46.) Institutions should have a clear policy in place on who shall determine what research is exempt under .46.101(b).

*www.hhs.gov/ohrp/policy/hsdc95-02.html

More About Research

These boxes take a closer look at important topics in educational research. See a full listing of these boxes, starting on page xii.

Research Tips

These boxes provide practical pointers for doing research. See a full listing of these boxes on page xii.

RESEARCH TIPS

Key Terms to Define in a Research Study

- Terms necessary to ensure that the research question is sharply focused
- Terms that individuals outside the field of study may not understand
- Terms that have multiple meanings
- Terms that are essential to understanding what the study is about
- Terms to provide precision in specifications for instruments to be developed or located

Another important point to remember is that often it is a compound term or phrase that needs to be defined rather than only a single word. For example, the term *nondirective therapy* will surely not be clarified by precise definitions of *nondirective* and *therapy,* since it has a more specific meaning than the two words defined separately would convey. Similarly, such terms as *learning disability, bilingual education, interactive video,* and *home-centered health care* need to be defined as linguistic wholes.

Here are three definitions of the term *motivated to learn.* Which do you think is the clearest?

1. Works hard
2. Any classroom *judged* (by an observer spending at least one day per week for four to five weeks) to possess all the following characteristics:
   a. No more than three children working with the same materials at the same time
   b. The teacher never spending more than 20 minutes per day addressing the class as a group
   c. At least half of every class period open for students to work on projects of their own choosing at their own pace
   d. Several (more than three) sets of different kinds of educational materials available for every student in the class to use

CONTROVERSIES IN RESEARCH

High-Stakes Testing

High-stakes testing refers to the use of tests (often only a single achievement test) as the primary, or only, basis for decisions having major consequences. For students, such consequences include retention in grade and/or the denial of diplomas and awards. For schools, they include public praise or condemnation, sanctions, and financial rewards or punishments. "In state after state, legislatures, governors, and state boards, supported by business leaders, have imposed tougher requirements in mathematics, English, science, and other fields, together with new tests by which the performance of both students and schools is to be judged."*

For years, tests had been used as one indicator of performance; what was new was exclusive reliance on them. "The backlash, touching virtually every state that has instituted high-stakes testing, arises from a spectrum of complaints. A major complaint is that the focus on testing and obsessive test preparation, sometimes beginning in kindergarten, is killing innovative teaching and curricula and driving out good teachers. Other complaints are that (conversely) the standards on which the tests are based are too vague and that students have not been taught the material on which the tests are based; or that the tests are unfair to poor and minority students or to those who lack test-taking skills; or that the tests put too much stress on young children. And some argue that they are too long (in Massachusetts they can take up to 13 hours!) or too tough or simply not good enough."*

In response, the American Educational Research Association developed a position statement of "conditions essential to sound implementation of high-stakes educational testing programs."† It contained 14 specific points, 4 of the most important being that (1) such decisions about students should not be based on test scores alone; (2) tests should be made fairer to all students; (3) tests should match the curriculum; and (4) the reliability and validity of tests should continually be evaluated.

Two examples of responses to the guidelines were the following:

- "In the face of too much testing with far too severe consequences, the AERA positions, if implemented, would be a step forward relative to current practice."‡
- "The statement reflects what is desired for all state tests and assessments. But, just as all students have not yet met the standards, not all state tests and assessments will immediately meet the goals contained in this statement."§

What do you think? Are the complaints about high-stakes tests warranted?

*Schrag, P. (2000, August). High stakes are for tomatoes. *Atlantic Monthly, 286,* 19.

†American Educational Research Association. (2000). Position statement of the American Educational Research Association concerning high-stakes testing in pre-12 education. *Educational Researcher, 29* (11), 24–35.

‡Neill, M. (2000). Quoted in Initial responses to AERA's position statement concerning high-stakes testing. *Educational Researcher, 29* (11), 28.

§Martin, W. (2000). Quoted in Initial responses to AERA's position statement concerning high-stakes testing. *Educational Researcher, 29* (11), 27.

ones, or only problems involving subtraction, the test will be unrepresentative and hence not provide information from which valid inferences can be made.

One key element in **content-related evidence of validity**, then, concerns the adequacy of the sampling of directions, and so on. Regardless of the adequacy of the questions in an instrument, if they are presented in an inappropriate format (such as giving a test written in English to children whose English is minimal), valid results cannot be obtained. For this reason, it is important

Controversies in Research

These boxes highlight a controversy in research to provide you with a greater understanding of the issue. See a full listing of these boxes on page xiii.

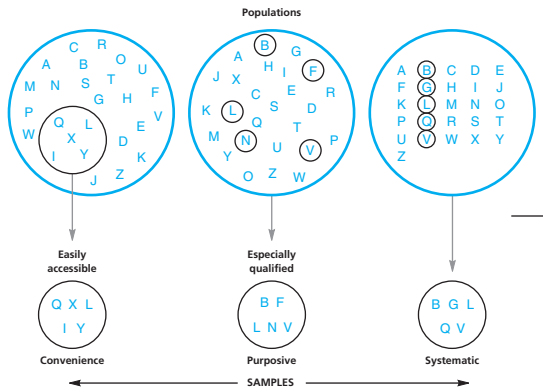


Figure 6.6 *Nonrandom Sampling Methods*

Figures and Tables

Numerous figures and tables explain or extend concepts presented in the text.

Research Reports

Published research reports are included at the conclusion of methodology chapters. The reports have been annotated to illustrate important points.

RESEARCH REPORT

Physical Education in Urban High School Class Settings: Features and Correlations between Teaching Behaviors and Learning Activities

Howard Z. Zeng, Raymond Leung, and Michael Hipscher
The City University of New York, Brooklyn College
Wenhao Liu
Slippery Rock University (PA)

Abstract

This study examined the features and correlations between teaching behaviors and learning activities in urban high school physical education (PE) class settings using direct instruction model. Participants were sixteen urban high school PE teachers and their students. Results indicated that the teachers spent their class times on the major teaching behaviors were informing 28.8%, Structuring 25.4%, Observing 17.0%, and Feedback 9.2%. The students spent their class times on the major learning activities were: Motor Engaged 56.2%, Cognitive Engaged 20.7%, and Waiting for a Turn 9.7%. Correlation analyses revealed that Informing, Questioning, and Feedback teaching behaviors were positively associated with Motor Engaged and Cognitive Engaged learning activities. When the teachers exhibited the behavior category of None of the Above, their students showed no motor and cognitive learning activities engagements. Findings suggested that, PE teachers should develop and employ teaching behaviors that promote and demonstrate physical skills and fitness because those teaching behaviors are positively associated with students' physical activity levels.

"As follows"

Research on teaching in physical education (RT-PE) has accomplished remarkably with respect to how teaching behaviors are related to learning outcomes (Brophy & Good, 1986; Graham & Heimerer, 1981; Keating, Kulinna & Silverman, 1999; Martin & Kulinna, 2004; Silverman, Tyson & Morford, 1988). Silverman (1991) defined RT-PE as "research on what teachers and students do and how this affects or relates to learning and to the social dynamics of the class." (p. 352). This definition is broad and tells us that, when a study is conducted on teaching in physical education, both teacher's teaching behaviors and student's learning activities should be included in the parameters of a study.

Prior research

Recently, research studies have provided sufficient information regarding the characteristics of effective teaching (Pangrazi, 2007; Kulinna, Cothran & Regualos, 2006; Siedentop & Tannehill, 2000). Based on the work done by previous researchers, the following characteristics were described as effective teaching/learning environments: (a) clear objectives and content covered; (b) well-organized and appropriate expectations; (c) meaningful task and high rates of success; (d) smooth transition and low rates of management time; (e) appropriate guidance and active supervision; (f) high rates in student-engaged time and low rates in student waiting time; and (g) teacher's enthusiasm and equitable support. The characteristics stated above have become important

Constitutive definition

guidelines for training novice teachers to grow to be an effective teacher (Pangrazi, 2007; Kulinna, Cothran & Regualos, 2006; Siedentop & Tannehill, 2000).

A number of previous studies in RT-PE focused on how teacher and student behaviors were associated with direct instruction, and eventually the direct instruction model in physical education was developed (Anderson, Evertson, & Brophy, 1979; Graber, 2001; Rosenshine, 1979; Rosenshine & Stevens, 1986; Sweeting & Rink, 1999). Rosenshine (1979) illustrated that direct instruction model in physical education possesses clear learning goals, adequate time for instruction and practice which is characterized by appropriate subject matters for students' abilities, low-level cognitive questions but meaningful task and high success by monitoring student performance and providing immediate and specific feedback.

Silverman, Tyson, and Morford (1988) found that students spending their class time on motor skill practice with teacher's feedback was positively associated with their motor learning achievement. Furthermore, regarding how time is spent in physical education classes, Silverman (1991) summarized that most students spent less than 30% of the class time on motor activities but the majority of the time on waiting, explanation/demonstration, and/or receiving information.

Faucette and Patterson (1990) compared teaching behaviors and students' activity levels taught by specialists versus non-specialists in elementary physical education class settings. The researchers found that specialists employed informing, structuring, questioning, feedback, and reward teaching behaviors whereas non-specialists utilized silent monitoring and attending teaching behaviors, thereby suggesting that different teaching behaviors caused different students' activity levels. The rates of students' activity levels were 35.0% and 16.5% taught by specialists and non-specialists respectively (Faucette & Patterson, 1990).

Good review

More recently, researchers have used different observation instruments to investigate, describe, and compare the differences and similarities of teaching behaviors and student learning activities in physical education classes (Banville, 2006; Banville & Rikard, 2001; Keating et al., 1999; Martin & Kulinna, 2005; Mitcell & Castelli, 2003). Significant linear correlations between teaching behaviors and learning activities with correlation coefficients ranging from .26 to .42 have been found (Martin & Kulinna, 2004, 2005; Mitcell & Castelli, 2003).

Potentially useful
Small

Martin and Kulinna's study (2005) involved 43 physical education teachers (20 from elementary school, 11 from middle school, and 12 from high school). The main purposes of their study were: (a) to determine whether teachers' intentions to teach lessons more active physically were related to teaching behaviors (e.g., demonstrating and promoting fitness); and (b) whether teacher behaviors were associated with how much time their students spent on various activities. They found that general instruction and management behaviors were negatively related to students' moderate to vigorous physical activities; general instruction behaviors, however, were positively associated with students' sitting and standing behaviors.

Although RT-PE have accomplished plentifully, Silverman (1991) pointed out that the majority of studies in teaching physical education were conducted at the K-8 levels using preservice teachers as participants (even though 17 years after Dr. Silverman's famous general review for the accomplishments in the field of research in teaching physical education). Studies at the high school level were very limited, and the features of teaching behaviors and learning activities at the high school level were not well-documented. Hence, the relationship between teachers' teaching behaviors and students' learning activities in high school physical education classes remained unanswered. As a result, the present study was designed to extend previous research (K-8) by not only employing high

Justification

Analysis of the Study

PURPOSE/JUSTIFICATION

The purpose was "to examine the features and correlations between teaching behaviors and learning activities in urban high school physical education classes" that used direct instruction (p. 350). The main justification was to address a gap in the research literature on the relationship between physical education instructors' teaching behaviors and students' learning activities in secondary schools. The researchers sought "to extend previous research (K–8) by not only employing high school (9–12) physical education teachers as participants but also examining the characteristics of effective teaching in high school physical education classes" (p. 350).

Teachers and students (we assume their parents) provided informed consent prior to data collection. There appear to be no concerns regarding harm, confidentiality, or deception although the researchers noted they did not disclose to teachers the true nature of their class observations so as not to influence their normal teaching behavior.

DEFINITIONS

Formal definitions are not provided for the primary terms in the study: *teaching behaviors* and *learning activities*. Both terms are operationally defined by observational data collected from the Direct Instruction Behavior Analysis (DIBA) system. The DIBA included 14 categories, 8 relating to teaching behaviors and 6 assessing learning activities. These observational data were coded to produce the quantitative indicators "percentage of time" spent on specified behaviors and "rate per minute" (RPM) used to measure frequency for the 14 predefined categories. We think the study would have been improved by clarifying two DIBA definitions: (1) cognitively engaged—"listens to" and "gains information" and (2) response preparing—students "get ready" (see also Instrumentation).

Other key terms include *direct instruction*, *physical education classes*, and *urban high school*. The researchers provide a constitutive definition for "direct instruction model," which they describe as possessing "clear learning goals, adequate time for instruction and practice which is characterized by appropriate subject matters for students' abilities, low-level cognitive questions but meaningful task and high success by monitoring student performance and providing immediate and specific feedback" (p. 350). Definitions are not provided for *physical education classes* although the researchers list the type and duration of classes observed: basketball/fitness, volleyball/fitness, yoga, dance, soccer/fitness, weight lifting/fitness, and tennis. Similarly, *urban high school* is not defined but the researchers provide demographic information about each school site in terms of total student enrollment and racial/ethnic breakdown.

PRIOR RESEARCH

An extensive review of the research literature is provided to support the design and justification for the study. Citing both older and more recent research (studies published within five years from their study), the researchers do well in summarizing the major theoretical and empirical findings related to their research question. Moreover, they revisit their literature review findings in the discussion section. For example, the authors state that "the findings of this study were quite different from those of the Martin and Kulinna's study (2005)" (p. 354). In doing so, the authors situate their study within the context of the research literature.

HYPOTHESES

The hypothesis is not stated explicitly, but clearly implied. The authors' implied hypothesis is that teaching behaviors linked to direct instruction in physical education are correlated with student learning behaviors.

SAMPLE

The sample included 16 physical education teachers and their students from three urban high schools located in New York City, New York. Demographic information about the teachers was limited to gender and number of years teaching. The authors do not describe the student sample other than a narrative account of the pooled demographics of each of the three schools. This demographic information could have been presented more clearly for the reader had the authors included it in a separate table. Moreover, the authors neglected to include standard measures of socioeconomic status about the high schools such as the percentage of students receiving free/reduced lunch, and the percentage who are English language learners. The implied population is all high school physical education teachers and their students in the United States. Generalizing beyond the sample is limited as participating teachers were not

Each research report is critiqued by the authors, with both its strengths and weaknesses discussed.

Chapter Review

The chapter ends with a listing of the review resources available for students on the Online Learning Center Web site at www.mhhe.com/fraenkel9e.

Go back to the **INTERACTIVE AND APPLIED LEARNING** feature at the beginning of the chapter for a listing of interactive and applied activities. Go to the **Online Learning Center** at **www.mhhe.com/fraenkel9e** to take quizzes, practice with key terms, and review chapter content.

Main Points

Bulleted main points highlight the key concepts of the chapter.

Main Points

THE NATURE OF QUALITATIVE RESEARCH

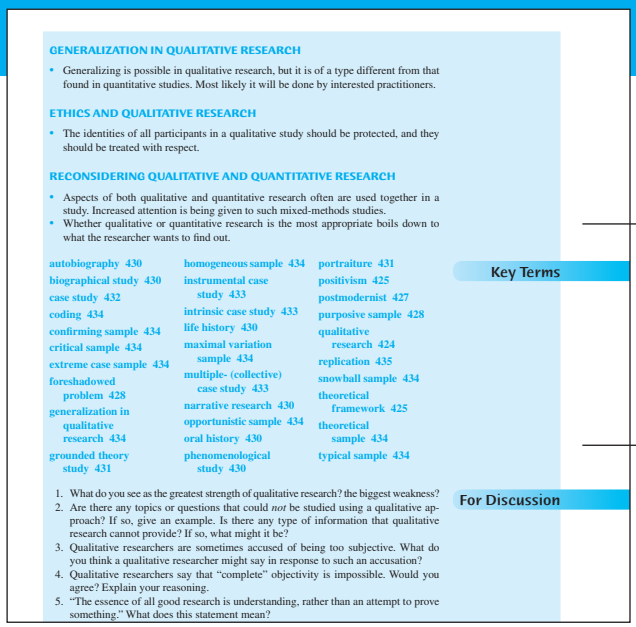
- The term *qualitative research* refers to studies that investigate the *quality* of relationships, activities, situations, or materials.
- The natural setting is a direct source of data, and the researcher is a key part of the instrumentation process in qualitative research.
- Qualitative data are collected mainly in the form of words or pictures and seldom involve numbers. Coding is the primary technique used in data analysis.
- Qualitative researchers are especially interested in how things occur and particularly in the perspectives of the subjects of a study.
- Qualitative researchers do not, usually, formulate a hypothesis beforehand and then seek to test it. Rather, they allow hypotheses to emerge as a study develops.
- Qualitative and quantitative research differ in the philosophical assumptions that underlie the two approaches.

STEPS INVOLVED IN QUALITATIVE RESEARCH

- The steps involved in conducting a qualitative study are not as distinct as they are in quantitative studies. They often overlap and sometimes are even conducted concurrently.
- All qualitative studies begin with a foreshadowed problem, the particular phenomenon the researcher is interested in investigating. Some qualitative researchers state propositions to help their data collection and also analysis.
- Researchers who engage in a qualitative study of some type usually select a purposive sample. Several types of purposive samples exist.
- There is no treatment in a qualitative study, nor is there any manipulation of variables.
- The collection of data in a qualitative study is ongoing.
- Conclusions are drawn continuously throughout the course of a qualitative study.

APPROACHES TO QUALITATIVE RESEARCH

- A biographical study tells the story of the special events in the life of a single individual.



GENERALIZATION IN QUALITATIVE RESEARCH

- Generalizing is possible in qualitative research, but it is of a type different from that found in quantitative studies. Most likely it will be done by interested practitioners.

ETHICS AND QUALITATIVE RESEARCH

- The identities of all participants in a qualitative study should be protected, and they should be treated with respect.

RECONSIDERING QUALITATIVE AND QUANTITATIVE RESEARCH

- Aspects of both qualitative and quantitative research often are used together in a study. Increased attention is being given to such mixed-methods studies.
- Whether qualitative or quantitative research is the most appropriate boils down to what the researcher wants to find out.

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Key Terms

1. What do you see as the greatest strength of qualitative research? the biggest weakness?
2. Are there any topics or questions that could *not* be studied using a qualitative approach? If so, give an example. Is there any type of information that qualitative research cannot provide? If so, what might it be?
3. Qualitative researchers are sometimes accused of being too subjective. What do you think a qualitative researcher might say in response to such an accusation?
4. Qualitative researchers say that "complete" objectivity is impossible. Would you agree? Explain your reasoning.
5. "The essence of all good research is understanding, rather than an attempt to prove something." What does this statement mean?

For Discussion

Key Terms

Key terms are listed with page references.

For Discussion

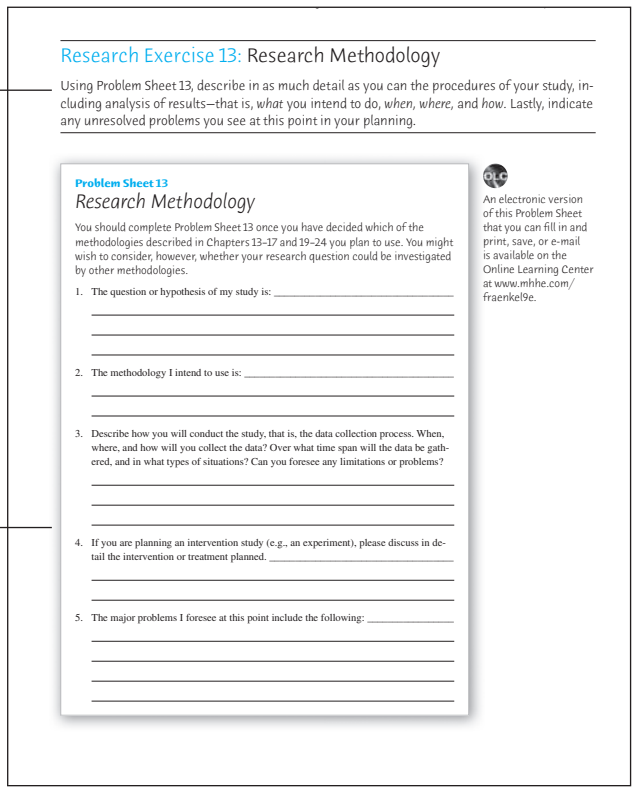
End-of-chapter questions are designed for in-class discussion.

Research Exercises

The research exercise explains how to fill in the Problem Sheet that follows.

Problem Sheets

Individually, the problem sheets allow students to apply their understanding of the major concepts of each chapter. As a whole, they walk students through each step of the research process.



Research Exercise 13: Research Methodology

Using Problem Sheet 13, describe in as much detail as you can the procedures of your study, including analysis of results—that is, *what* you intend to do, *when*, *where*, and *how*. Lastly, indicate any unresolved problems you see at this point in your planning.

Problem Sheet 13

Research Methodology

You should complete Problem Sheet 13 once you have decided which of the methodologies described in Chapters 13–17 and 19–24 you plan to use. You might wish to consider, however, whether your research question could be investigated by other methodologies.

1. The question or hypothesis of my study is: _____
2. The methodology I intend to use is: _____
3. Describe how you will conduct the study, that is, the data collection process. When, where, and how will you collect the data? Over what time span will the data be gathered, and in what types of situations? Can you foresee any limitations or problems?
4. If you are planning an intervention study (e.g., an experiment), please discuss in detail the intervention or treatment planned. _____
5. The major problems I foresee at this point include the following: _____

OLC

An electronic version of this Problem Sheet that you can fill in and print, save, or e-mail is available on the Online Learning Center at www.mhhe.com/fraenkel9e.

PART 1

Introduction to Research

Research takes many forms. In Part 1, we introduce you to the subject of educational research and explain why knowledge of the various types of research is of value to educators. Because research is but one way to obtain knowledge, we also describe several other ways and compare the strengths and weaknesses of each. We give a brief overview of educational research methodologies to set the stage for a more extensive discussion in later chapters. Lastly, we discuss criticisms of the research process.

1 The Nature of Research

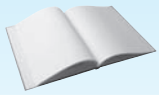
OBJECTIVES **Studying this chapter should enable you to:**

- Explain what is meant by the term "educational research" and give two examples of the kinds of topics educational researchers might investigate.
- Explain why a knowledge of scientific research methodology can be of value to educators.
- Name and give an example of four ways of knowing other than the method used by scientists.
- Explain what is meant by the term "scientific method."
- Give an example of six different types of research methodologies used by educational researchers.
- Describe briefly what is meant by critical research.
- Describe the differences among descriptive, associational, and intervention-type studies.
- Describe briefly the difference between basic and applied research.
- Describe briefly the difference between quantitative and qualitative research.
- Describe briefly what is meant by mixed-methods research.
- Describe briefly the basic components involved in the research process.

INTERACTIVE AND APPLIED LEARNING After, or while, reading this chapter:

Go to the Online Learning Center at www.mhhe.com/fraenkel9e to:

- Learn More About Why Research Is of Value



Go to your online Student Mastery Activities book to do the following activities:

- Activity 1.1: Empirical vs. Nonempirical Research
- Activity 1.2: Basic vs. Applied Research
- Activity 1.3: Types of Research
- Activity 1.4: Assumptions
- Activity 1.5: General Research Types

"Dr. Hunter? I'm Molly Levine. I called you about getting some advice about the master's degree program in your department."

"Hello, Molly. Pleased to meet you. Come on in. How can I be of help?"

"Well, I'm thinking about enrolling in the master's degree program in marriage and family counseling, but first I want to know what the requirements are."

"I don't blame you. It's always wise to know what you are getting into. To obtain the degree, you'll need to take a number of courses, and there is also an oral exam once you have completed them. You also will have to complete a small-scale study."

"What do you mean?"

"You actually will have to do some research."

"Wow! What does that involve? What do you mean by research, anyway? And how does one do it? What kinds of research are there?"

To find out the answers to Molly's questions, as well as a few others, read this chapter.

Some Examples of Educational Concerns

- A high school principal in San Francisco wants to improve the morale of her faculty.
- The director of the gifted student program in Denver would like to know what happens during a typical week in an English class for advanced placement students.
- An elementary school counselor in Boise wishes he could get more students to open up to him about their worries and problems.
- A tenth-grade biology teacher in Atlanta wonders if discussions are more effective than lectures in motivating students to learn biological concepts.
- A physical education teacher in Tulsa wonders if ability in one sport correlates with ability in other sports.
- A seventh-grade student in Philadelphia asks her counselor what she can do to improve her study habits.
- The president of the local PTA in Little Rock, parent of a sixth-grader at Cabrillo School, wonders how he can get more parents involved in school-related activities.

Each of these examples, although fictional, represents a typical question or concern facing many of us in education today. Together, these examples suggest that teachers, counselors, administrators, parents, and students continually need information to do their jobs. Teachers need to know what kinds of materials, strategies, and activities best help students learn. Counselors need to know what problems hinder or prevent students from learning and how to help them with these problems. Administrators need to know how to provide an environment for happy and productive learning. Parents need to know how to help their children succeed in school. Students need to know how to study to learn as much as they can.

Why Research Is of Value

How can educators, parents, and students obtain the information they need? Many ways of obtaining information, of course, exist. One can consult experts, review books and articles, question or observe colleagues with relevant experience, examine one's own past experience, or even rely on intuition. All these approaches suggest possible ways to proceed, but the answers they provide are not always reliable. Experts may be mistaken; source documents may contain no insights of value; colleagues may have no experience in the matter; and one's own experience or intuition may be irrelevant or misunderstood.

This is why a knowledge of scientific research methodology can be of value. The scientific method provides us with another way of obtaining information—information that is as accurate and reliable as we can get. Let us compare it, therefore, with some of the other ways of knowing.

Ways of Knowing

SENSORY EXPERIENCE

We see, we hear, we smell, we taste, we touch. Most of us have seen fireworks on the Fourth of July, heard the whine of a jet airplane's engines overhead, smelled a rose, tasted chocolate ice cream, and felt the wetness of a rainy day. The information we take in from the world through our senses is the most immediate way we have of knowing something. Using sensory experience as a means of obtaining information, the director of the gifted-student program mentioned at the start of this chapter, for example, might visit an advanced placement English class to see and hear what happens during a week or two of the semester.

Sensory data, to be sure, can be refined. Seeing the temperature on an outdoor thermometer can refine our knowledge of how cold it is; a top-quality stereo system can help us hear Beethoven's Fifth Symphony with greater clarity; similarly, smell, taste, and touch can all be enhanced, and usually need to be. Many experiments in sensory perception have revealed that we are not always wise to trust our senses too completely. Our senses can (and often do) deceive us: The gunshot we hear becomes a car backfiring; the water we see in the road ahead is but a mirage; the chicken we thought we tasted turns out to be rabbit.

Sensory knowledge is undependable; it is also incomplete. The data we take in through our senses do not account for all (or even most) of what we seem to feel is the range of human knowing. To obtain reliable knowledge, therefore, we cannot rely on our senses alone but must check what we think we know with other sources.

AGREEMENT WITH OTHERS

One such source is the opinions of others. Not only can we share our sensations with others, we can also check on the accuracy and authenticity of these sensations: Does this soup taste salty to you? Isn't that John over there? Did you hear someone cry for help? Smells like mustard, doesn't it?

Obviously, there is a great advantage to checking with others about whether they see or hear what we do. It can help us discard what is untrue and manage our lives more intelligently by focusing on what is true. If, while hiking in the country, I do not hear the sound of an approaching automobile but several of my companions do and alert me to it, I can proceed with caution. All of us frequently discount our own sensations when others report that we are missing something or "seeing" things incorrectly. Using agreement with others as a means of obtaining information, the tenth-grade biology teacher in Atlanta, for example, might check with her colleagues to see if they find discussions more effective than lectures in motivating their students to learn.

The problem with such common knowledge is that it, too, can be wrong. A majority vote of a committee is no guarantee of the truth. My friends might be wrong about the presence of an approaching automobile, or the automobile they hear may be moving away from rather than toward us. Two groups of eyewitnesses to an accident may disagree as to which driver was at fault. Hence, we need to consider some additional ways to obtain reliable knowledge.

EXPERT OPINION

Perhaps there are particular individuals we should consult—experts in their field, people who know a great deal about what we are interested in finding out. We are likely to believe a noted heart specialist, for example, if he says that Uncle Charlie has a bad heart. Surely, a person with a PhD in economics knows more than most of us do about what makes the economy tick. And shouldn't we believe our family dentist if she tells us that back molar has to be pulled? To use expert opinion as a means of obtaining information, perhaps the physical education teacher in Tulsa should ask a noted authority in the physical education field whether ability in one sport correlates with ability in another.

Well, maybe. It depends on the credentials of the experts and the nature of the question about which they are being consulted. Experts, like all of us, can be mistaken. For all their study and training, what experts know is still based primarily on what they have learned from reading and thinking, from listening to and observing others, and from their own experience. No expert, however, has studied or experienced all there is to know in a given field, and thus even an expert can never be totally sure. All any expert can do is give us an opinion based on what he or she knows, and no matter how much this is, it is never all there is to know. Let us consider, then, another way of knowing: logic.

LOGIC

We also know things logically. Our intellect—our capability to reason things out—allows us to use sensory data to develop a new kind of knowledge. Consider the famous syllogism:

All human beings are mortal.
Sally is a human being.
Therefore, Sally is mortal.

To assert the first statement (called the *major premise*), we need only generalize from our experience about the mortality of individuals. We have never experienced anyone who was not mortal, so we state that all human beings are. The second statement (called the *minor premise*) is based entirely on sensory experience. We come in contact with Sally and classify her as a human being. We don't have to rely on our senses, then, to know that the third statement (called the *conclusion*) must be true. Logic tells us it is. As long as the first two statements are true, the third statement must be true.

Take the case of the counselor in Philadelphia who is asked to advise a student on how to improve her study habits. Using logic, she might present the following argument: Students who take notes on a regular basis in class find that their grades improve. If you take notes on a regular basis, then your grades should improve as well.

This is not all there is to logical reasoning, of course, but it is enough to give you an idea of another way of knowing. There is a fundamental danger in logical reasoning, however: It is only when the major and minor premises of a syllogism are *both* true that the conclusion is guaranteed to be true. If either of the premises is false, the conclusion may or may not be true.*

*In the note-taking example, the major premise (all students who take notes on a regular basis in class improve their grades) is probably *not* true.

There is still another way of knowing to consider: the method of science.

THE SCIENTIFIC METHOD

When many people hear the word *science,* they think of things like white lab coats, laboratories, test tubes, or space exploration. Scientists are people who know a lot, and the term *science* suggests a tremendous body of knowledge. What we are interested in here, however, is science as a method of knowing. It is the **scientific method** that is important to researchers.

What is this method? Essentially it involves testing ideas in the public arena. Almost all of us humans are capable of making connections—of seeing relationships and associations—among the sensory information we experience. Most of us then identify these connections as "facts"—items of knowledge about the world in which we live. We may speculate, for example, that our students may be less attentive in class when we lecture than when we engage them in discussion. A physician may guess that people who sleep between six and eight hours each night will be less anxious than those who sleep more or less than that amount. A counselor may feel that students read less than they used to because they spend most of their free time watching television. But in each of these cases, we do not really know if our belief is true. What we are dealing with are only guesses or hunches, or as scientists would say, hypotheses.

What we must do now is put each of these guesses or hunches to a rigorous test to see if it holds up under more controlled conditions. To investigate our speculation on attentiveness scientifically, we can observe carefully and systematically how attentive our students are when we lecture and when we hold a class discussion. The physician can count the number of hours individuals sleep, then measure and compare their anxiety levels. The counselor can compare the reading habits of students who watch different amounts of television.

Such investigations, however, do not constitute science unless they are made public. This means that all aspects of the investigation are described in sufficient detail so that the study can be repeated by anyone who questions the results—provided, of course, that those interested possess the necessary competence and resources. Private procedures, speculations, and conclusions are not scientific until they are made public.

There is nothing very mysterious, then, about how scientists work in their quest for reliable knowledge. In reality, many of us proceed this way when we try

to reach an intelligent decision about a problem that is bothering us. These procedures can be boiled down to five distinct steps.

1. First, there is a problem of some sort—some disturbance in our lives that disrupts the normal or desirable state of affairs. Something is bothering us. For most of us who are not scientists, it may be a tension of some sort, a disruption in our normal routine. Examples would be if our students are not as attentive as we wish or if we have difficulty making friends. To the professional scientist, it may be an unexplained discrepancy in one's field of knowledge, a gap to be closed. Or it could be that we want to understand the practice of human sacrifice in terms of its historical significance.
2. Second, steps are taken to define more precisely the problem or the questions to be answered, to become clearer about exactly what the purpose of the study is. For example, we must think through what we mean by *student attentiveness* and why we consider it insufficient; the scientist must clarify what is meant by *human sacrifice* (e.g., how does it differ from murder?).
3. Third, we attempt to determine what kinds of information would solve the problem. Generally speaking, there are two possibilities: study what is already known or carry out a piece of research. As you will see, the first is a prerequisite for the second; the second is a major focus of this text. In preparation, we must be familiar with a wide range of possibilities for obtaining information, so as to get firsthand information on the problem. For example, the teacher might consider giving a questionnaire to students or having someone observe during class. The scientist might decide to examine historical accounts or spend time in societies where the practice of human sacrifice exists (or has until recently). Spelling out the details of information gathering is a major aspect of planning a research study.
4. Fourth, we must decide, as far as it is possible, how we will organize the information that we obtain. It is not uncommon, in both daily life and research, to discover that we cannot make sense of all the information we possess (sometimes referred to as *information overload*). Anyone attempting to understand another society while living in it has probably experienced this phenomenon. Our scientist will surely encounter this problem, but so will our teacher unless she has figured out how to handle the questionnaire and/or observational information that is obtained.
5. Fifth, after the information has been collected and analyzed, it must be interpreted. While this step may seem straightforward at first, this is seldom the case. As you will see, one of the most important parts of research is to avoid kidding ourselves. The teacher may conclude that her students are inattentive because they dislike lectures, but she may be misinterpreting the information. The scientist may conclude that human sacrifice is or was a means of trying to control nature, but this also may be incorrect.

In many studies, there are several possible explanations for a problem or phenomenon. These are called *hypotheses* and may occur at any stage of an investigation. Some researchers state a hypothesis (e.g., "Students are less attentive during lectures than during discussions") right at the beginning of a study. In other cases, hypotheses emerge as a study progresses, sometimes even when the information that has been collected is being analyzed and interpreted. The scientist might find that instances of sacrifice seemed to be more common after such societies made contact with other cultures, suggesting a hypothesis such as: "Sacrifice is more likely when traditional practices are threatened."

We want to stress two crucial features of scientific research: freedom of thought and public procedures. At every step, it is crucial that the researcher be as open as humanly possible to alternative ways of focusing and clarifying the problem, collecting and analyzing information, and interpreting results. Further, the process must be as public as possible. It is not a private game to be played by a group of insiders. The value of scientific research is that it can be *replicated* (i.e., repeated) by anyone interested in doing so.*

The general order of the scientific method, then, is as follows:

Identifying a problem or question
Clarifying the problem
Determining the information needed and how to obtain it
Organizing the information
Interpreting the results

In short, the essence of all research originates in curiosity—a desire to find out how and why things

*This is not to imply that replicating a study is a simple matter. It may require resources and training—and it may be impossible to repeat any study in exactly the same way it was done originally. The important principle, however, is that public evidence (as opposed to private experience) is the criterion for belief.

happen, including why people do the things they do, as well as whether or not certain ways of doing things work better than others.

A common misperception of science fosters the idea that there are fixed, once-and-for-all answers to particular questions. This contributes to a common, but unfortunate, tendency to accept, and rigidly adhere to, oversimplified solutions to very complex problems. While certainty is appealing, it is contradictory to a fundamental premise of science: All conclusions are to be viewed as tentative and subject to change, should new ideas and new evidence warrant revision. It is particularly important for educational researchers to keep this in mind, since the demand for final answers from parents, administrators, teachers, and politicians can often be intense. An example of how science changes is shown in the More About Research box on page 8.

For many years, there has been a strong tendency in Western culture to value scientific information over all other kinds. In recent years, the limitations of this view have become increasingly recognized and discussed. In education, we would argue that other ways of knowing, in addition to the scientific, should at least be considered.

As we have seen, there are many ways to collect information about the world around us. Figure 1.1 on page 10 illustrates some of these ways of knowing.

Types of Research

All of us engage in actions that have some of the characteristics of formal research, although perhaps we do not realize this at the time. We try out new methods of teaching, new materials, new textbooks. We compare what we did this year with what we did last year. Teachers frequently ask students and colleagues their opinions about school and classroom activities. Counselors interview students, faculty, and parents about school activities. Administrators hold regular meetings to gauge how faculty members feel about various issues. School boards query administrators, administrators query teachers, teachers query students and each other.

We observe, we analyze, we question, we hypothesize, we evaluate. But rarely do we do these things systematically. Rarely do we observe under controlled conditions. Rarely are our instruments as accurate and reliable as they might be. Rarely do we use the variety of research techniques and methodologies at our disposal.

The term **research** can mean any sort of "careful, systematic, patient study and investigation in some field of knowledge."[1] **Basic research** is concerned with clarifying underlying processes, with the hypothesis usually expressed as a theory. Researchers engaged in basic research studies are not particularly interested in examining the effectiveness of specific educational practices. An example of basic research might be an attempt to refine one or more stages of Erickson's psychological theory of development. **Applied research**, on the other hand, *is* interested in examining the effectiveness of particular educational practices. Researchers engaged in applied research studies *may or may not* want to investigate the degree to which certain theories are useful in practical settings. An example might be an attempt by a researcher to find out whether a particular theory of how children learn to read can be applied to first graders who are non readers. Many studies combine the two types of research. An example would be a study that examines the effects of particular teacher behaviors on students while also testing a theory of personality.

Many methodologies fit within the framework of research. If we learn how to use more of these methodologies where they are appropriate and if we can become more knowledgeable in our research efforts, we can obtain more reliable information upon which to base our educational decisions. Let us look, therefore, at some of the research methodologies we might use. We shall return to each of them in greater detail in Parts 4 and 5.

QUANTITATIVE AND QUALITATIVE RESEARCH

Another distinction involves the difference between **quantitative** and **qualitative research**. Although we shall discuss the basic differences between these two types of research more fully in Chapter 18, we will provide a brief overview here. In the simplest sense, quantitative data deal primarily with numbers, whereas qualitative data primarily involve words. But this is too simple and too brief. Quantitative and qualitative methods differ in their assumptions about the purpose of research itself, methods utilized by researchers, kinds of studies undertaken, role of the researcher, and degree to which generalization is possible.

Quantitative researchers usually base their work on the belief that the world is a *single reality* that can be approximated by careful study. Qualitative researchers,

Chaos Theory

The origins of what is now known as **chaos theory** are usually traced to the 1970s. Since then, it has come to occupy a prominent place in mathematics and the natural sciences and, to a lesser extent, in the social sciences.

Although the physical sciences have primarily been known for their basic laws, or "first principles," it has long been known by scientists that most of these laws hold precisely only under ideal conditions that are not found in the "real" world. Many phenomena, such as cloud formations, waterfall patterns, and even the weather, elude precise prediction. Chaos theorists argue that the natural laws that are so useful in science may, in themselves, be the exception rather than the rule.

Although precise prediction of such phenomena as the swing of a pendulum or what the weather will be at a particular time is in most cases impossible, repeated patterns, according to a major principle of chaos theory, can be discovered and used, even when the content of the phenomena is chaotic. Developments in computer technology, for example, have made it possible to translate an extremely long sequence of "data points," such as the test scores of a large group of individuals, into colored visual pictures of fascinating complexity and beauty. Surprisingly, these pictures show distinct patterns that are often quite similar across different content areas, such as physics, biology, economics, astronomy, and geography. Even more surprising is the finding that certain patterns recur as these pictures are enlarged. The most famous example is the "Mandlebrot Bug," shown in Photographs 1.1 and 1.2. Note that Photograph 1.2 is simply a magnification of a portion of Photograph 1.1. The tiny box in the lower left corner of Photograph 1.1 is magnified to produce the box in the upper left-hand corner of Photograph 1.2. The tiny box within this box is then, in turn, magnified to produce the larger portion of Photograph 1.2, including the reappearance of the "bug" in the lower right corner. The conclusion is that even with highly complex data (think of trying to predict the changes that might occur in a cloud formation), predictability exists if patterns can be found across time or when the scale of a phenomenon is increased.

IMPLICATIONS FOR EDUCATIONAL RESEARCH

We hope that this brief introduction has not only stimulated your interest in what has been called, by some, the third revolution in science during the twentieth century (the theory of relativity and the discovery of quantum mechanics being the first two), but that it helps to make sense out of what we view as some implications for educational research. What are these implications?*

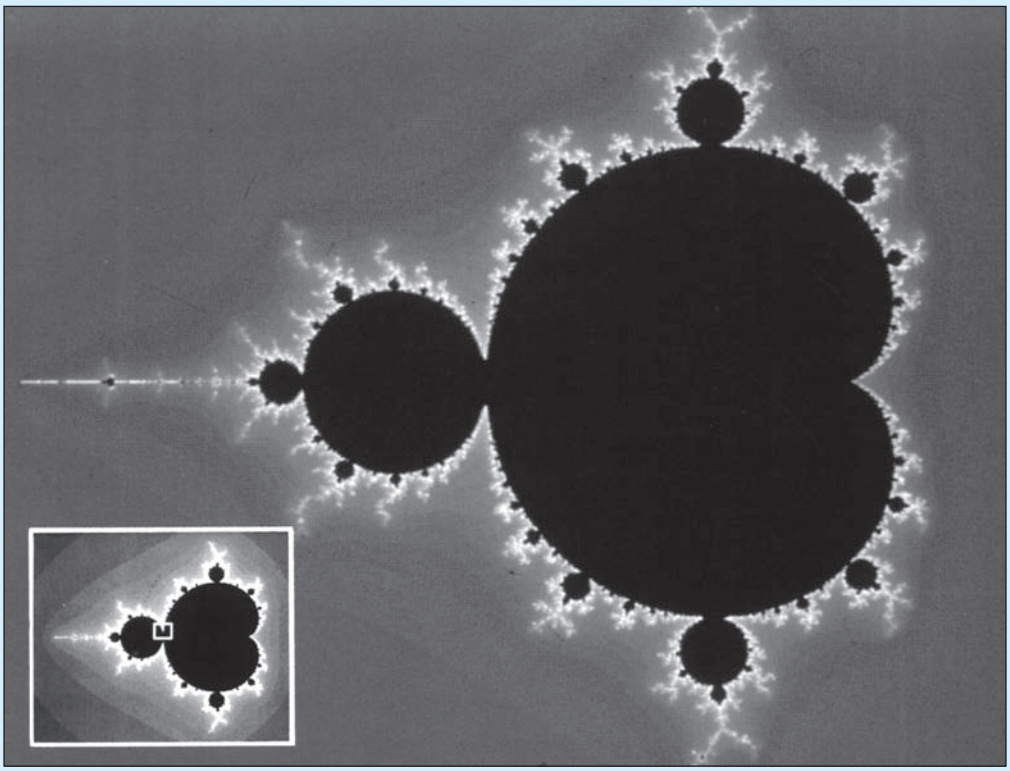
If chaos theory is correct, the difficulty in discovering widely generalizable rules or laws in education, let alone the social sciences in general, may not be due to inadequate concepts and theories or to insufficiently precise measurement and methodology, but may simply be an unavoidable fact about the world. Another implication is that whatever "laws" we do discover may be seriously limited in their applicability—across geography, across individual and/or group differences, and across time. If this is so, chaos theory provides support for researchers to concentrate on studying topics at the local level—classroom, school, agency—and for repeated studies over time to see if such laws hold up.

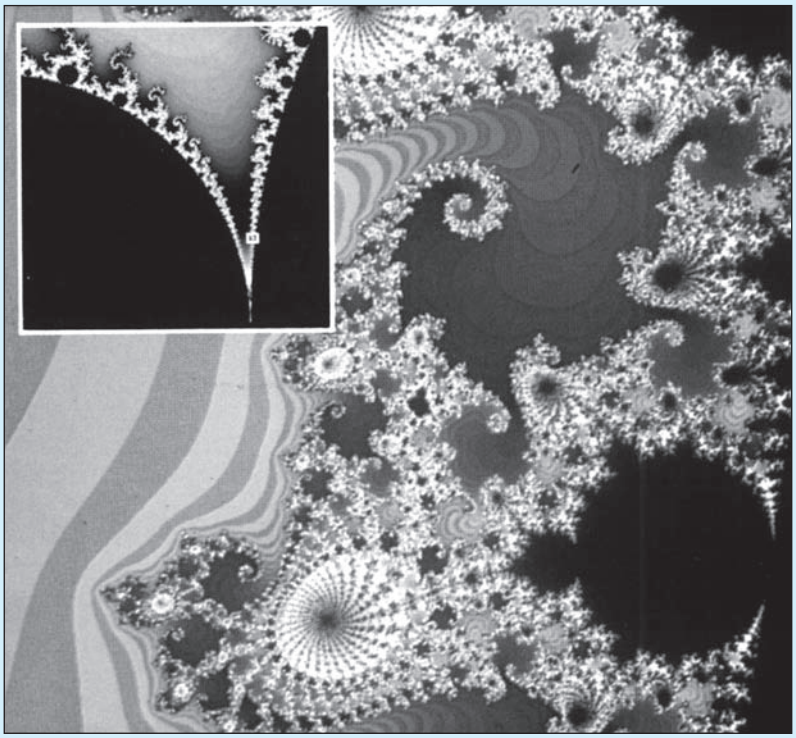
Another implication is that educators should pay more attention to the intensive study of the exceptional or the unusual, rather than treating such instances as trivial, incidental, or "errors." Yet another implication is that researchers should focus on predictability on a larger scale—that is, looking for patterns in individuals or groups over larger units of time. This would suggest a greater emphasis on long-term studies rather than the easier-to-conduct (and cheaper) short-time investigations that are currently the norm.

Not surprisingly, chaos theory has its critics. In education, the criticism is not of the theory itself, but more with misinterpretations and/or misapplications of it.† Chaos theorists do not say that all is chaos; quite the contrary, they say that we must pay more attention to chaotic phenomena and revise our conceptions of predictability. At the same time, the laws of gravity still hold, as, with less certainty, do many generalizations in education.

*For more extensive implications in the field of psychology, see Duke, M. P. (1994). Chaos theory and psychology: Seven propositions. *Genetic, Social and General Psychology Monographs, 120,* 267–286.

†See Hunter, W., Benson, J., & Garth, D. (1997). Arrows in time: The misapplication of chaos theory to education. *Journal of Curriculum Studies, 29,* 87–100.





Photographs 1.1 and 1.2 *The Mandlebrot Bug*

Source: Peitgen, H-O, & Richter, P. H. (1986). *The beauty of fractals.* Berlin: Springer-Verlag.