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Educators as Critical Thinkers

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OVERVIEW

Many students are surprised to learn that the study of research methods in many fields of inquiry, particularly education, is far more conceptual than technical. Learning about research involves new ways of thinking, and students of research could easily believe they are studying within a department of philosophy. These new ways of thinking are indeed intriguing to students. Some find them counterintuitive; others find them downright fascinating. Most would agree that thinking like a researcher is elegant, in a sense, and ultimately a very comfortable experience.

Astute thinking about research will enable you to understand published educational research and communicate effectively with other educational practitioners. Sharing your ideas

about research findings is one step toward improving learning for others. Your ability to understand research in education is enhanced by critical thinking skills. A thinking-skills approach to educational research views educators as critical, reflective practitioners.

THE VALUE OF EVIDENCE-BASED RESEARCH IN EDUCATION

Educational researchers are committed to improving the quality of education by increasing their knowledge of the art and science of teaching and the process of learning. Educational practitioners, such as teachers, counselors, administrators, and curriculum specialists, become most effective when their skills and classroom wisdom are combined with their knowledge of educational research. The National Research Council (2002) emphasized the value of research in education: “No one would think of getting to the Moon or of wiping out a disease without research. Likewise, one cannot expect reform efforts in education to have significant effects without research-based knowledge to guide them” (p. 1). But research by itself is not sufficient. We must constantly remind ourselves about the challenges we face when *interpreting* research. Davis (2007) notes that people “tend to pay greater attention to research studies that confirm their deeply held beliefs and assumptions than to studies that challenge their sensibilities” (p. 570). It is too easy to ignore research that doesn’t fit our way of understanding the world, and we must constantly guard against that mistake.

The goal of this book is to make educational research accessible to practicing educational professionals, those ultimately responsible for improving learning in classrooms. Making research accessible requires the ability to read and critique published educational research—and to think clearly about the entire process. Clearly, the effect of research on teaching and learning—a potentially profound influence—is dependent on our ability to understand, critique, and apply findings from high-quality published studies.

Each chapter of this book is concerned with an important facet of educational research, one that enables you to read research reports with greater comprehension and critical appraisal. By the time you reach the end of this book, you will understand the most important principles and concepts of educational research, those that enable you to read and evaluate research reports. This positions you to make sound decisions about applying educational research in your practice. The final chapter will introduce you to the next level: preparing to conduct your own research. Learning how to think critically about the research process and how to evaluate published research will enable you to prepare a clearly written research proposal in any area of education.

Practitioners’ ability to understand the process of educational research—and to evaluate it—became especially important with the No Child Left Behind Act of 2001. That is because the Act placed great emphasis on using scientific research to determine what works best in our schools. The idea that science can contribute to our understanding of teaching and learning is decades old (see Gage’s 1978 classic, *The Scientific Basis of the Art of Teaching*). Scientific research applied to education is a national priority, evidenced by the What Works Clearinghouse (<http://ies.ed.gov/ncee/wwc/>) established by the U.S. Department of Education’s Institute of Education Sciences, shifting educators’ focus to scientific research for help in determining best practices in our schools. The scientific emphasis highlights the value of empirical, systematic, rigorous, objective procedures to obtain valid knowledge about teaching and learning. The What

Works Clearinghouse (WWC) favors intervention research for guidance (e.g., evaluating one treatment against a comparison), the type of research best suited for uncovering cause-and-effect relationships. Yet, as you will see, there are many other scientific approaches to research that are valuable for practicing educators.

Educators who are in a position to evaluate scientific research in education are in the best place to understand the challenges of educational reform. Conducting research is the most reliable method of acquiring new knowledge about teaching and learning. Alternative “ways of knowing” (common sense, intuition, authority, tradition, etc.) have proven less useful for advancing our understanding of the complex process of learning. Educational research in recent years has revealed information that is quietly changing the way we teach. Research by Howard Gardner (2006), for example, supports our asking, “How are you smart?” instead of “How smart are you?” His notion is that multiple intelligences applied in classrooms engage students who benefit from alternatives to the traditional verbal (lecture) approach to teaching. Such classrooms, with the backing of research, capitalize on abilities aligned with music, movement, social interaction, introspection, and spatial (visual) relations, among others. Further, Gardner (2009) builds a strong case for a future mind that will “demand capabilities that until now have been mere options” (p. 2). The “synthesizing” mind of the future “takes information from disparate sources, understands and evaluates that information objectively, and puts it together in ways that make sense” (p. 3). This requires critical thinking about research—the focus of this book.

Both scientists and educators live with doubt, yet each has specific expertise (practice knowledge and research knowledge), creating the potential for a valuable “feedback loop” and partnership (Dynarski, 2010). The professionalism of teaching encourages teacher action research in the classroom (not mere implementation of others’ findings) and exchanges with educational researchers that extend well beyond dissemination. To that end, educators who are able to conduct and interpret research while thinking critically are in the best position to advance the scientific basis of the art of teaching.

Other recent research reveals that passivity and learning do not mix well, because learners of all ages seem to learn best through real-life, meaningful activity (such as hands-on projects and social interaction). In fact, much contemporary research in neuroscience and cognitive psychology supports the early progressive methods of learning popular nearly 100 years ago (see Schunk, 2008). Today, many of the progressive ideas of John Dewey have been rebadged and are commonly referred to under the label of *constructivism*, to highlight the fact that learners must actively construct, or build, an understanding for meaningful retention. One example of the illuminating value of scientific research can be found in the teaching of reading and the National Reading Panel (National Institute of Child Health and Human Development, 2000). You will find many other examples of programs and practices in education that meet the criterion of solid research support at the What Works Clearinghouse as well as the Promising Practices Network (www.promisingpractices.net).

The scope of research problems in education is indeed huge, and the value of applying research findings in the classroom to improve learning and retention cannot be overstated. Useful research findings stem from large-scale scientific experiments; from very local, small-scale teacher action research in the classroom; and from everything in between. The same research principles, such as controls to minimize bias and measurements that minimize error,

HIGHLIGHT AND LEARNING CHECK 1.1 SCIENCE AND WISDOM

Studying the art and science of teaching and learning can be viewed as a melding of scientific principles, critical thinking, and personal craft knowledge. Explain how both science and experiential wisdom can help us understand the personal, creative, and scientific bases of education.

are used across the full spectrum of research approaches in education. These important principles—and how to think clearly about them—are described in the following chapters.

Reading journal articles that report research results is not easy. (It does get easier with practice.) The scholarly literature in any field is often dense and filled with jargon; it is always slow reading. But I believe understanding and applying research holds the key to improving the art and science of teaching and learning. You could probably go to easier sources, such as the popular but biased media (magazines, television, etc.), devotees of pendulum swings, or tidbits off the Internet, for information about “what works.” (I am reminded of the man who lost his wallet in a dark alley but searched under the street lamp because the light was better.) However, the simplicity of those sources greatly distorts the complex reality. The *scientific* basis of the art of teaching is revealed only by research literature. Understanding published scientific literature involves bringing new light to previously dim areas (to continue the lost wallet metaphor). This book will illuminate the process of educational research so you are in a better position to read, understand, and apply research in your own practice. You can also begin the process of conducting your own research. These tasks involve critical thinking. Many classroom educators develop the skill of critical thinking when reflecting on their practice. The value of critical thinking, reflective teaching, and teacher action research is explored in the following sections.

THE VALUE OF CRITICAL THINKING APPLIED TO EDUCATIONAL RESEARCH

- **Critical thinking:** Careful, astute reasoning that includes conceptualization, synthesis, analysis, and evaluation. Critical thinkers reach sound conclusions about the connections between observations and ideas using reasoned reflection.

Critical thinking requires becoming comfortable with arguments, data and their interpretation, and the reasonable conclusions that follow. Too often in education discourse, faulty assumptions about “what works” cloud clear thinking or blind us from objective appraisal. The National Institute for Literacy (2006) highlighted the need for critical thinking in education:

More than ever, educators are expected to make decisions that guarantee quality instruction. As knowledge emerges, so do philosophies, opinions, and rhetoric about definitions of instructional excellence. From policy makers to classroom teachers, educators need ways to separate misinformation from genuine knowledge and to distinguish scientific research from poorly supported claims. (para. 2)

Although there is little debate over the value of critical thinking in our complex society, different disciplines (e.g., cognitive psychology, philosophy, behavioral psychology) focus on different definitions by highlighting a variety of abilities and processes (Huit, 1998). Most definitions of critical thinking center on analyzing and evaluating ideas using reasoned reflection. The cognitive process of analysis involves breaking up complexity into its constituent components to see how they are connected—tightly, loosely, or not at all. The process of evaluation involves examining a process and making a judgment using one or more standards as a context or benchmark. Research is often evaluated against the scientific standard, yet there is variance of opinion about what constitutes “science.” This is especially true in education. One person might maintain that scientific research in education is defined by its specific methods (intervention, random assignment, rigorous controls, etc.), while another might argue that science is defined by systematic inquiry and an explicit chain of reasoning. Either way, critical thinkers in education understand how reasoning and data analysis can help advance the scientific basis of education.

Recognizing Bias: The Hallmark of Critical Thinking

Critical thinking is inconsistent with bias. Researchers constantly guard against bias because they know the strength of its influence and the ease—almost the natural tendency—to fall within its traps. The value of *disproving* in science may not be readily apparent, in part because we have a “dangerous” tendency (a bias) to value *confirmation* (support) for a claim, seeking that at the expense of the more informative task of disproving the claim (Goldacre, 2010, p. 178). Goldacre’s illustration (p. 177) clarifies this bias (a recurring problem in science): Your desk has four index cards labeled A, B, 2, and 3, respectively. Each card is double sided—a letter on one side, a number on the other. The claim being tested here is: “All cards with a vowel on one side have an even number on the other.” Which two cards should be overturned to test this claim? Goldacre reports that most people select cards A and 2. But this strategy is problematic because those findings may only *support* (be consistent with) the claim. It reveals information about *some*, not all, cards. A smarter choice would be A and 3, because you can disprove the claim if you find an odd number behind A or a vowel on the flip side of 3. You could support the claim, too, by finding an even number behind A. The B card is irrelevant to the claim (it is not a vowel); card 2 is limited to support only. Goldacre refers to the almost instinctive choice of cards A and 2 as a “cognitive illusion” and a “failing of intuition” (p. 178).

Confirmation bias is only one of many biases that threaten good judgment when evaluating educational research. Other “natural” and dangerous tendencies include believing there are patterns in random events (e.g., seeing a “winning streak” in a random coin toss sequence), perceiving associations that don’t exist, interpreting cause from mere association, and evaluating new evidence in accordance with prior thinking or beliefs (Goldacre, 2010).

Yet another bias in research might be dubbed the “inclusion bias.” When one finds a difference between a new program and a comparison program, attention immediately turns to what the new program includes at the expense of ignoring what it *excludes*. A new program, for example, may include the use of 3D graphics to deliver lessons in algebra (but gone are confusing symbols). If achievement in the 3D program is higher, it is easy to jump to the conclusion that 3D is the responsible factor when in fact simply eliminating symbol confusion could yield the same result. If that is true, then delivering traditional instruction while eliminating symbol confusion might yield achievement effects as high as the those seen with the 3D program. This is merely one more example of misinterpreting research results as a result of not thinking clearly about alternative explanations. Many other well-researched biases will be explored more fully in the remaining chapters.

Goldacre (2010, pp. 157–158) also offers critical thinkers valuable advice for spotting “tricks” that would otherwise mislead readers of research. These tricks are summarized below:

- Language that suggests correlation proves causation (roosters’ crowing does not “raise” the sun)
- Significant relationships that surface after the analysis of “anything with everything” (apparent statistical significance in a random number table being inevitable, given many statistical tests)
- Comparisons after an intervention of groups that were not equivalent at the start, or use of unfair control groups (“apples and oranges”)
- Ignoring research “dropouts” (“lost” participants often do not conform to the anticipated results)
- “Cleaning” data in ways that support the hypothesis (e.g., eliminating extreme cases only if they are contrary to the presumed effect)

■ **Confirmation bias:**
The tendency to value support for a claim at the expense of more informative disproof.

- Extending the study until desired results appear (or cutting it short when the presumed effect appears)
- “Torturing” the data (digging deeper and deeper into subgroup analysis or exhausting various types of statistical tests) until the desired outcome appears
- Failing to recognize “publication bias” (suppressing negative findings)

Goldacre also reminds critical thinkers to constantly guard against “cognitive illusions” (similar to optical illusions) that explain “why clever people believe stupid things” (2010, p. 172). These include:

- Interpreting patterns among randomness (think of faces within clouds)
- Interpreting a return to normal as a treatment effect when the change was inevitable (such as when a return to normal after the worst coincides with treatment)
- Interpreting confirmatory data—described earlier—as more valuable than data that disprove a claim or theory (some claims can be immediately disproved with data, yet supporting data are often sought)
- Interpreting new evidence in ways that align with prior beliefs (otherwise the dissonance is uncomfortable)
 - Interpreting exceptional cases (e.g., miracle cures) as representative
 - Using data influenced by social factors (e.g., the tendency to agree with others)

HIGHLIGHT AND LEARNING CHECK 1.2 “BAD SCIENCE”

Bad science is characterized by biases and maneuvers that mislead others by claims critical thinkers would identify as faulty. Consider a “research-based” claim that a foreign language can be learned via audiotapes while sleeping. Identify one or more “tricks” that might be used to mislead others into thinking that conclusion is true.

Recognizing intentional or unintentional research maneuvers that affect outcomes and guarding against predispositions that lead to biased interpretations are challenging for everyone. (Try avoiding an optical illusion—you can’t. Cognitive illusions are “natural” but not inevitable.) Attempts to do so, however, provide valuable practice that leads to a style of critical thinking that becomes easier over time. Understanding the entire research process—the goal of the remaining chapters in this book—will enable you to disentangle “bad science” from good science, the type of rigorous scientific reasoning that is a hallmark of critical thinking.

Bountiful Opportunity

There is bountiful opportunity for critical thinking in educational research—and much room for debate among the sharpest critical thinkers. The No Child Left Behind Act of 2001, undoubtedly the most sweeping federal reform of public education in our history, demanded educators’ attention to critical thinking about research and data-driven decisions. Thinking critically involves evaluating research conclusions by first analyzing the research process that led to those conclusions. Merely having data is not a sufficient condition for making sound conclusions.

Here is an example. Suppose a sample of homeschooled high school students outperformed a sample of public school students on a standardized achievement test of reading and mathematics. Does one conclude that parents are better instructors than certified teachers? No. The research process might reveal ample opportunities for distortion of data combined with a faulty chain of logic rather than reasoned reflection. One common illogical argument leads to the conclusion that because two events occur together, one causes the other (e.g., that a concurrent

sharp increase in the homeschooling of high school students and rise in SAT or ACT scores are directly related). If homeschooled students did outperform public school students, one might reasonably ask, would the homeschooled students have performed even *better* had they been in public school? Might a different subsample of homeschooled students—more representative—score *lower* than public school students? Would a different measure of achievement lead to different findings?

The point is that educational data can be easily misinterpreted using noncritical thinking. Sound conclusions require reasoned reflection: that is, using logical reasoning while attending to alternative explanations (ones that can be ruled out with additional data). The use of noncritical thinking leaves us vulnerable to the misunderstandings favored by those who push pseudoscience, whereby claims are offered that *appear* to have a scientific basis but do not. The problem of “sciencey” language in the absence of critical attention to alternative explanations gives rise to “bad science” (Goldacre, 2010), described above.

In addition to the cognitive skills of analysis and evaluation, Facione (2011) describes several other abilities involved in critical thinking, including interpretation, inference, explanation, and self-regulation. *Interpretation* involves other skills, such as determining meaning and significance, and is itself aided by the clear formation of categories. Critical consumers of educational research can read published reports and sort the information rapidly into mental categories (qualitative case study, experimental intervention, etc.), supporting its interpretation (e.g., the study means that math skills often erode over the summer) and its significance (e.g., there is need for refresher sessions). *Inference* entails identifying relevant information and drawing appropriate conclusions. Critical consumers of educational research might determine, for example, that all available evidence suggests that reducing class size does not necessarily lead to changes in students’ achievement. *Explanation* involves describing and justifying reasoning. Critical consumers of educational research can describe valid findings (e.g., a generalized widening achievement gap) and state the procedures used to determine such findings’ validity (e.g., multidimensional measures of achievement on representative samples). *Self-regulation* involves thinking about thinking (self-examination) and making appropriate corrections (self-correction). Critical consumers of educational research may ask themselves, “Does my bias influence my reactions to these findings?” or “Do I understand the implications of the research design?”

Overall, critical thinking in educational research involves examining research ideas and assessing the credibility of data-driven conclusions. You must judge the quality of the information gathered and weigh the evidence presented. Clear thinking and logic prevail, regardless of the astonishing variation in types of educational research. Quantitative (“statistics”) research, for instance, involves deductive and inductive reasoning from theory toward verification (but never veering too far from theory). Qualitative research, by comparison, involves reason and meaning as described by Shank (2006). He believes this type of practical reasoning is evident when we interpret clues, form impressions, recognize patterns, and generate explanations. He believes that metaphorical thinking (the use of the metaphor in reasoning) is especially valuable in qualitative research. Further, Shank believes that research is nothing more than practical logic and careful reasoning. He offers three “visions” of critical thinking about research: (1) the “mirror,” where critical thinking is sharp and reflective; (2) the “window,” where critical thinking is simple and elegant; and (3) the “lantern,” where critical thinking is flexible and creative (p. 143).

Critical thinking in education is one protection against the susceptibility to common fallacies and errors in reasoning. Trochim (2006), for example, described two common types

HIGHLIGHT AND LEARNING CHECK 1.3 CAREFUL REASONING

Critical thinking in education involves careful reasoning about research and its implications. This includes being on watch for alternative explanations and possible misinterpretations of findings. Explain how the question “What else might explain these findings?” illustrates qualities of critical thinking.

of fallacies: ecological fallacies and exception fallacies. *Ecological fallacies* occur when group data are used to make an inference about an individual. That a school has the highest reading scores does not suggest that every student at that school is a strong reader. Concluding that Bob, a student at the school, must not have reading difficulties would be an ecological fallacy. *Exception fallacies* result from generalized conclusions based on a single case. An observation of Bob’s astonishing reading gains would not suggest that the teacher’s approach works similarly for all students. Many other fallacies threaten the value of research in education, and these are explored in the chapters that follow. Diverse approaches to educational research and the clear thinking of educators hold the greatest promise for advancing the scientific basis of education.

In summary, we know that critical thinking is *careful* (watchful, cautious), *astute* (sharp, clear), and *analytical* (logical in the sense of examining interrelating elements to draw conclusions). Educators need critical thinking to assess the worth of claims about our understanding of a phenomenon (such as a widening achievement gap or increasing dropout rate). Most researchers in education would agree that critical thinking involves *conceptualization* (idea building), *synthesis* (putting together), *analysis* (pulling apart), and *evaluation* (judgment) of information obtained from reflection and observation (or experience), all leading to reasoned conclusions and implications. Such reasoning guards against fallacious thinking. Table 1.1 shows a compilation of the qualities of critical thinkers compared to noncritical thinkers.

Table 1.1 Qualities of Critical Thinkers Compared to Noncritical Thinkers

Critical Thinkers	Noncritical Thinkers
Evaluate information objectively	Tend to shape findings to fit preconceptions
Consider counter examples and counterevidence	Tend toward confirmation bias (favor evidence that supports preconceptions)
Use analytic judgment, recognizing components of complexity	Make oversimplified, snap judgments
Consider alternative and multiple perspectives	Use biased, narrow, egocentric, or prejudiced frames of reference and single interpretations
Reflect on vital ideas	Rely on preconceptions with little curiosity
Sort multiple types of data (information)	Rely on little information or ignore new information
Use logic, drawing conclusions after weighing evidence	Fall victim to logical fallacies, persuaded by intuition or emotion
Sort and recognize missing data	Use limited data with information gaps or voids
Examine assumptions	Confuse assumptions with facts
Assess validity of claims	Accept claims unchallenged

Critical Thinkers	Noncritical Thinkers
Display creative, imaginative, inquisitive ideas	Display traditional, narrow-minded, self-centered, habitual, or rigid thinking
Consider context and reach tentative, integrative, defensible conclusions	Stereotype, overgeneralize, and reject counterevidence and exceptions
Remain skeptical; question authority and conventional wisdom	Believe without doubting and revert to wishful thinking and conventional wisdom
Reason with clarity, precision, relevance	Think with disjointed or irrelevant ideas
Self-correct; test conclusions against standards	Avoid evaluating ideas
Make data-driven, reasoned decisions based on converging evidence	Decide using limited evidence and unchallenged ideas
Reason with reference to research and existing knowledge base	Make judgments based on illogical and irrational thinking
Justify well-reasoned conclusions	Jump to conclusions without explanation
Assess data for validity	Accept data as infallible
Raise well-reasoned questions	Respond without inquiry
Welcome problem solving	Ignore problems
Recognize logical inconsistencies	Overlook fallacies
Seek patterns during analysis	Overlook trends and relationships
Search for biases	Accept information without scrutiny
Seek multiple sources of information	Rely on a single or favorite source

There are immense benefits to learning how to think critically about research in education. The skills of reasoned judgment transfer to other disciplines, such as psychology and the health sciences. The ability to use critical thinking also enables us to filter and evaluate the relentless bombardment of “cases” (arguments for and against important issues) disseminated by the popular mass media. Many media reports about research findings—earning cover story status in reputable publications—are laughable, yet do require attention (e.g., the report on a study revealing that “simply having a husband creates an extra seven hours of housework each week” [Bennett & Ellison, 2010, p. 43] and another on the research behind cautions such as the stroller warning label “Remove child before folding” [Gibbs, Ball, Silver, Dias, & Yan, 2009]). Further, Davis (2007) warns,

You’d be surprised at the quantity of poorly supported information in the guise of empirical research that has made its way to the front lines of

HIGHLIGHT AND LEARNING CHECK 1.4 CRITICAL THINKERS’ QUESTIONS

Evaluating research in education requires an array of skills related to the evaluation of information. Much attention is focused on the research conclusions. One may ask, are they credible? Do they logically follow the findings? Are there alternative explanations? Discuss how the skills of critical thinking enable you to answer these questions. Compare how a critical thinker might approach the task of evaluating research compared to a noncritical thinker.

HIGHLIGHT AND LEARNING CHECK 1.5 CRITICAL THINKERS' EVALUATION

Critical thinkers and noncritical thinkers are distinguished by differences in the ways they evaluate information (data). Presume that new data revealed that the achievement gap defined by differences in socioeconomic status was eliminated in 10 large urban school districts in five states. How might critical thinkers and noncritical thinkers approach the evaluation of this information?

public schools. The literature is rife with half-truths, popular myths, contradictions, poorly designed studies, misinterpreted findings, and conclusion soaked in the personal biases and deeply held assumptions of research studies. (p. 572)

The problem is confounded by the fact that many people attend to research conclusions that align with their personal beliefs (often based on anecdotes and limited observations). At the same time, they may ignore research reports that challenge those values, beliefs, and assumptions.

Whatever the source, the flaws and fallacies accompanying claims that “research shows” are not easy to recognize or challenge. Critical thinking about research claims in education and other fields can be a lifelong project, fine-tuned by experience and punctuated by fewer and fewer episodes of illogical thinking. Understanding research in education affords the opportunity to develop this skill, in part because the field is rife with uncritical acceptance of procedures and policies. Educational

fads, theories, and practices can be challenged most effectively using reasoned arguments and new data or, often, the reanalysis of existing data.

Critical thinking is a prerequisite for evaluating scientifically based research. Although the No Child Left Behind Act originally implied that scientific evidence favors true experimental designs (using random assignment to treatment and comparison groups) as the basis for recommending changes in practice, the American Educational Research Association (2008, para. 1) offered a more reasoned (“alternate”) definition of scientifically based research: the “use of rigorous, systematic, and objective methodologies to obtain reliable and valid knowledge.” The key requirements include:

- A “logical evidenced-based chain of reasoning”
- “Methods appropriate to the questions posed”
- Design and instruments that yield reliable findings
- Data and their analysis sufficient to support conclusions
- Information to evaluate the generalization of findings
- Accessibility of data “for reanalysis, replication, and the opportunity to build on findings”
- Use of designs that “substantially reduce plausible competing explanations” for the results

Honed skills in critical thinking enable you to evaluate the scientific worth of research in education. Was the chain of reasoning flawed? Do the conclusions logically follow the collected and analyzed data? Are there other plausible explanations for the findings? This is simply the start of a list of questions related to the scientific value of research. The remaining chapters of this book will explore these (and other) questions in more detail.

■ **Reflective practice:** Educators thinking critically about the art and science of teaching, collecting data to test ideas, and revising their practice to solve classroom and workplace problems or improve learning.

THE VALUE OF EDUCATORS AS REFLECTIVE PRACTITIONERS

Educational administrators, counselors, and teachers are making steady progress in **reflective practice**, their own brand of research and critical thinking. Often dubbed action research, this approach to improving classrooms and schools centers on school professionals who use

a variety of research methods with the intent of learning more about their practice and making immediate improvements based on the implications of data analysis. The potential to effect positive change is huge for classroom teachers who study their classroom learning processes. Teachers who adopt a “practice as inquiry” approach to their work find it natural to systematically examine their teaching by recording what was done (and why) and how it might be improved, collecting data to learn more about their practice, analyzing the data, and reflecting on the implications of findings for change. Few would argue that teachers are in the best position to institute data-driven improvements in practice immediately. However, to do so they must understand the research process, how to take advantage of it, and how to think clearly about the meaning of educational data. As noted by Dynarski (2010), “knowledge drawn from science doesn’t come with instructions on how to put it into practice” (p. 61). Putting it into practice is the work of teachers, counselors, and administrators, but educators who do not think clearly about research and understand its process not only may be overwhelmed by the sheer amount of research, but also may make poor decisions if they uncritically accept the most current and widely touted methods offered by commercial advertisers and mass media outlets.

Lest you remain unconvinced that teachers benefit from reflective practice and an understanding of research in education, consider an example of one reflective practitioner: Sarah Brown Wessling, a high school English teacher and the 2010 National Teacher of the Year. I caught up with Ms. Wessling, who teaches at Johnston High School in Iowa, and we had a chance to talk about action research and reflective practice. A portion of the interview appears below.

INTERVIEW WITH SARAH BROWN WESSLING, 2010 NATIONAL TEACHER OF THE YEAR

Question: You are now recognized as the nation’s top teacher. I know you value teacher research and reflective practice, trying many new ideas before creating a successful model of teaching. Do you have advice for other teachers who might hesitate to take calculated risks in the classroom for the benefit of students’ understanding?

Answer: Often as I travel, people ask me some equivalent of “What’s your secret?” The answer may be disappointing. There isn’t a secret. I have developed into a very deliberate and precise designer of instruction. I take risks in the classroom without being whimsical, I model curiosity without being frivolous, and I indulge in my passions without embarrassment. I work to go beyond reflecting or contemplating on my practice; I find ways to deconstruct it. Whether it’s an action research project with a practicum student, filming a class discussion and analyzing how we arrive at the kinds of questions that drive us to more complexity, or carefully looking at the kind of feedback I give students and honestly answering whether or not it would help me become a better writer, I work to repeat

and bring into habit the instruction that works and then systematically aim to eliminate the instruction that doesn’t.

Question: The recognition of National Teacher of the Year undoubtedly came, in part, because you encourage other teachers to think in reflective ways about their teaching practice. You also open up your own classroom to many observers and value their collaboration within a learning community—a type of shared responsibility. In what ways can reflective practice and collaborative research within a learning community not only improve classroom practice but also enhance the whole profession of teaching?

Answer: I advocate and illustrate a learner-centered pedagogy. Unlike the picture of this pedagogy we too often create for teachers, this philosophy means creating a web of rigorous content, real-world experience, and inquiry-based experiences around the learner. The teacher, too, becomes part of the web, a force of purpose, guidance, and curiosity. The teacher must also be a learner, an expert on process and metacognition.

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Question: Teacher action research is often collaborative and qualitative—going well beyond simple test scores. How can this type of collaboration and assessment be useful for your own students?

Answer: I see the world in stories. I relish the transformative power of language that can divide and unite us.

When I look in a classroom, I see a story in every learner, unique and yearning to be read. Creating a community for learning means creating more than a classroom; it means constantly intertwining our stories in a way that reveals our potential. I've long known that my story of learning and teaching has never really been about me. My students would tell you, time and again, that it's my passion that permeates the classroom atmosphere each day and makes them want to join in. They would tell you that I worked to see the potential in each one of them that they couldn't see in themselves.

Question: I know you value 21st-century skills, placing heavy emphasis on problem solving, critical thinking, and models of inquiry. Why are these skills so important now?

Answer: Every single person who walks into my classroom becomes part of our landscape for learning. Being a learner-centered teacher means respecting who students are right now. This means creating community by building a shared purpose and values. Cultivating this kind of environment begins when I relinquish the notion that I have a right answer or that I am a sieve of knowledge. At once, this liberates and challenges students. They recognize that their model is one of inquiry, of questioning, of thinking. While I am careful to construct the parameters of our pursuits and am relentless about modeling processes for learning, we are unequivocally "in it together." By truly putting students at the center, I can foster meaning-making experiences for all learners.

TEACHER RESEARCHERS AS CRITICAL THINKERS

Because critical thinking involves keen observation and reflection plus the cognitive skills associated with analysis and evaluation, it can be said that teacher researchers are critical thinkers. Examples of their work reveal why this is the case. Diane Painter (2000), for example, studied how students who use higher-order thinking skills develop expanded expectations of their learning. She stated,

I decided to conduct a teacher research project to investigate what happens when students have the opportunity to set their own goals and objectives, and work together to research a topic of their own choosing. . . . I wanted to closely look at the student interactions, the literacy and cooperative learning skills the students exhibit . . . and reflect upon [their work] within the realm of the constructivist philosophy of teaching. (para. 4)

Painter's review of the literature on brain research suggested that educators attend to learner diversity by providing varied methods for making sense of ideas in a context where challenge is moderate. Painter's after-school computer club provided the ideal study site where students were challenged to develop their own knowledge rather than receiving prepackaged information in a workbook. She observed that the school's computer club was a social activity, forming a knowledge building community as well as a means of formulating new ideas. This description conforms to a constructivist model of learning. By looking at Painter's results and analysis of the after-school program, other teachers may easily recognize how key components of extracurricular activities might be incorporated into daily lessons as a means to encourage all students in creative problem solving.

Reflective teacher Kristina Hedberg (2002) also provided an illustration of critical thinking in the classroom. As a fourth-grade teacher of English for speakers of other languages (ESOL), Hedberg was intent on developing a strategy to enhance students' comprehension and

retention of content in a social studies curriculum. Her analysis of the complex learning process convinced her of the need to link new information with previous knowledge. After carefully considering the factors that impacted her students' reading comprehension, she decided on a method (SQ3R, meaning **s**urvey, **q**uestion, **r**ead, **r**ecite, and **r**evue) that capitalized on students' using their background knowledge to attach meaning to new information, thereby increasing its retention. Hedberg used multiple sources of data (*triangulation*) to answer several research questions, and after inspecting patterns and trends, she carefully drew conclusions based on her observations. Her most important conclusion was that using the SQ3R method increased students' comprehension because they interacted with text in more meaningful ways.

Here is another example of one teacher's critical thinking in the classroom. Kindergarten and first-grade teacher Gail Ritchie (2000) thought about ways to meet state history standards of learning in a play-based classroom. Her data collection included careful observations in the form of student interviews, surveys, responses to open-ended questions, and products that revealed learning; parent questionnaires; photographs and videotapes; and field notes and reflective memories. Ritchie's critical thinking was revealed by her reflective journals and her analysis of the entries that noted the significance of her data. Her evaluation of her efforts to teach required objectives through play led not only to her conclusion that play-based strategies were effectively meeting required history objectives, but also to her discovery of the value of "spiraling" in helping her young students build stronger mental connections among abstractions.

Still other teachers are using critical thinking in action research to their advantage. Sally Bryan (2000) compared learning outcomes in a traditional classroom to those in an inquiry-oriented, project-based classroom that focused on student-centered utilization of knowledge. Angie McGlinchey (2002) investigated how nutrition instruction and student knowledge affected the eating habits of fifth graders. Barbara Poole and Kerry Smith (2000) wondered, "What motivates children to read independently?" (para. 1). Curran Roller (1998) asked, "How is the learning process affected by the inclusion of graphing calculators in the trigonometry & math analysis curriculum?" (para. 3). And Tonya Baskerville and Tamie Campbell (1999) wondered whether students would learn better if they were aware of their strongest learning styles.

Especially noteworthy are critical thinking teachers Karen Dellett, Georgene Fromm, and Susan Karn with advisor Ann Cricchi (1999), who developed critical thinking skills among their own third- and fourth-grade students. Here is a portion of their research summary (abstract):

Our research was designed to investigate what happens when third and fourth grade students learn and apply strategies to develop meta cognitive behaviors. Data analysis focused on student responses in thinking journals. Additional data was gathered from such sources as surveys, reflective chats, and field notes. By incorporating thinking strategies in our classrooms we observed a shift in student behavior. Students demonstrated increased self-reliance, a new awareness of thinking capabilities, an ability to make connections to prior knowledge, the ability to take a risk as they explored solutions to particular problems, and an emerging awareness of thinking strategies. Through this process we realized that our professional practice was impacted as much, if not more, than our students' emerging understanding of how they think. (para. 1)

HIGHLIGHT AND LEARNING CHECK 1.6 PRACTICE AS INQUIRY

Teacher action researchers are scientists in their classrooms. They use critical thinking to test ideas by collecting data and revising their practice. Explain how you could adopt a "practice as inquiry" philosophy in the classroom to illustrate an educator's role as a reflective practitioner skillful in critical thinking.

HIGHLIGHT AND LEARNING CHECK 1.7 TEACHER ACTION RESEARCHERS

The claim is that teacher action researchers are critical thinkers. Explain how data collection in the classroom illustrates many components of critical thinking.

All of the teacher research projects described in this section were culled from the Teacher Action Research website at George Mason University (<http://gse.gmu.edu/research/tr/>) in Fairfax, Virginia. This entire collection displays how teachers reflect on and evaluate their practice, pose a researchable question, analyze collected data to uncover patterns, consider alternative explanations, and reach sound conclusions, given the data at hand. Teacher action researchers use a large variety of research strategies to answer their questions. These diversified research methods and techniques—and the scientific thinking accompanying them—are covered in some detail in the remaining chapters.

UNDERSTANDING INCONSISTENCIES IN RESEARCH

Teacher action researchers, reflective practitioners, and critical consumers of research are often frustrated by the simple fact that scientists appear to constantly change their minds! Making sense of inconsistencies in research is a challenge for researchers and reflective practitioners alike. The challenge is lessened by astute, critical thinking. In education, too often what works well in one setting with one group will not “replicate,” or yield similar results, with a change in setting or people (a “peekaboo” phenomenon). In education, Davis (2007) reminds us that, even when readers of research find a glimmer of consistency, “even the most credible research is subject to differing interpretations and rarely depicts the final word or indispensable truth” (p. 577). *This argues for replication of research findings within one’s own classroom or workplace.*

It is quite common for two research studies, both designed to answer the same question, to yield **discrepant findings** and opposite conclusions. We know that changes in *context* may have a great influence on education outcomes. Other likely explanations for inconsistent results can be found in the *design* and *procedural* differences among studies. How can opposing findings be explained? By a catastrophic error in analysis? No, not usually. By fundamental differences in the methods used to answer the question? Yes, very likely. What differences are the most likely explanations? The answer to this question is explored in the following paragraphs.

Charter Schools

Consider examples from the research base on charter schools, heavily debated due to inconsistent research findings (Viadero, 2010). Very often, we find differences in *instrumentation*, or the process of collecting data in a research study. What measures were used to assess achievement or evaluate learning among charter schools? Were measures collected in similar ways across studies? Were *gains* in achievement considered? Did differences between charter and traditional schools exist in targeted *outcomes* (reading, math, science, English proficiency, creativity, etc.) and how they were assessed (e.g., standardized national or state test vs. arbitrary levels of proficiency)? Might charter school students have higher going-to-college rates despite no difference in test scores? Did qualitative measures (interviews, observations, document analysis, etc.) yield results that converged with statistical measures? Because such differences are likely contributors to contrary findings, it becomes clear that instrumentation yields clues to discrepant findings.

Another explanation for opposing conclusions may be found in *sampling*, or the process used to select research participants. This is a likely possibility because students’ characteristics

- **Discrepant findings:** Research outcomes that are inconsistent (or in opposition) across studies. Such findings are often explained by differences in research methods and procedures.

often “moderate” intervention effects in education, creating the need for “It depends” qualifications. Might a charter school effect be more evident in middle schools compared to high schools? Do grade levels within middle schools make a difference? Might urban, suburban, or rural environments influence outcomes? Are retained students included in the data analysis supporting charter schools? Do findings vary across sexes or ethnic and socioeconomic classifications? Are underprepared students affected similarly by a charter environment? Students’ characteristics are bound to “intervene” to a greater or lesser extent, and thus charter schools with populations that differ from those in traditional schools simply cannot be meaningfully compared to traditional schools without attention to co-occurring differences. For example, studies may vary because of the length of time a charter school has been operating (e.g., first year vs. three to five years), and they may also vary because of *time frame* effects. Perhaps differences between chartered and traditional students appear only after three to five years. Further, fundamental differences in control procedures may affect outcomes. Were traditional school students “lottery losers” (described later in this chapter), thus controlling for factors that affect motivation? Did the researchers control for differences expected between those who chose charter schools versus those who did not (“apples to apples”)? Variation in research design also offers a clue to the puzzle of research contradiction (as does the statistical analysis of those designs).

Finally, how do charter schools differ among themselves? What *are* the charters (focus) that govern the school (philosophy and mission)? Does one type of charter rise above others on measured outcomes? Were start-up charters compared to conversion charters? Were there differences in school size, namely, small charter schools compared to large traditional schools? Were there wide differences in school resources, so frequently linked to educational outcomes? In the end, perhaps the most meaningful research question is not “Are charter schools better?” but “What factors led to the success of this particular charter school?”

Definitions

Different definitions also contribute to confusing, contradictory research findings in education. Blimling (2004) describes how different definitions are often used interchangeably. For example, *postsecondary education*, *university education*, and *college education* may or may not pertain to cosmetology schools, four-year universities, community colleges, or medical schools. Blimling concludes that when researchers fail to clearly define reference groups, contradictory information is bound to follow. He also notes that inconsistencies often result from research claims that only support one’s biases or worldview. Consider the trend of higher education spending. The recent trend may be increasing or decreasing, depending on whether the claim is based on total money spent, the percentage of a state’s budget, cost-adjusted dollars, the inclusion of private and for-profit colleges, or other factors. Bias related to **cherry picking**—citing only those studies that favor a preferred conclusion—only compounds the problem.

Blimling also explains research inconsistencies as a concept related to the “telephone game,” where a message is whispered from one person to another until the end of the line. The announcement of the last message is usually amusing because it does not match the first message. “Quoting social science statistics, moving from one source to another without a clear reference to the methodology, can function in the same way. That statistic gets repeated, interpreted, and edited to advance a particular point of view” (Blimling, 2004, p. 6). Blimling concludes that research in education is often “socially constructed” and imperfect, the result of “best guesses, estimates, and probabilities” (p. 7).

- **Cherry picking:** Use of selected research findings that support one’s favored conclusion while other findings are ignored. One of many biases found in arguments that lead to opposing conclusions.

Consider cooperative learning efforts as another example. Its implementation by one particular teacher may have positive effects on a very specific outcome with only one type of student at one point in time. A change in any one of those factors may offset or possibly reverse the positive effect. The truth, which is often frustrating, seems to be that there are few, if any, educational interventions that influence all types of students equally. That is why the most common answer to the question “What is the effect of _____ on students?” is probably “It depends.” You can fill in the blank with all sorts of variables in education such as class size, teacher training, homework, scheduling, teaching style, and on and on. Other areas of “frustrating” educational research (discrepant findings) include learning to read, charter school influences, effects of retention, and long-term influences of early intervention programs. In fact, the learning-to-read research has boiled over to what is commonly called the “reading research wars.” One explanation for education “wars” is related to implementation and the fact that many programs do not replicate in every school where they are applied. A single study will not answer questions related to generalization, but careful on-ground deliberation and reflection—the skills of critical thinking—will enable educators to make wise decisions (Dynarski, 2010).

HIGHLIGHT AND LEARNING CHECK 1.8 OPPOSING DATA

Research findings on many, if not most, topics in education are “inconsistent.” Explain why researchers answering the same research question can produce opposing data and reach different conclusions. Apply those ideas to two studies on the effects of class size on achievement that yield opposing results. How might those inconsistent results be explained?

Summary

Contradictory studies abound in education. The same research question, three different studies, three different outcomes, three different conclusions—it is all very common and often linked to differences in instrumentation, sampling, control issues, and definitions that surround an intervention.

CRITICAL THINKER ALERT 1.1 INCONSISTENT RESEARCH

Research results are often contradictory. Research inconsistencies are to be expected because results are a function of how research is designed, conducted, and analyzed. Further, similar findings are subject to different interpretations, sometimes radically so. Variation in definitions compounds the problem.

Discussion: How might three studies of, for example, year-round schooling and student achievement show that 12-month schooling increases achievement, decreases achievement, and leaves achievement unaffected, respectively? What study differences might explain those discrepant findings? Try another research topic, such as the impact of single-sex schools on student achievement.

RESEARCH IMPROVES EDUCATION: EDUCATIONAL DATA MINING

- **Data mining:** Procedures for generating useful information from raw data produced in educational settings, with the goal of improving learning outcomes.

Reflective practitioners in education, those using critical thinking, not only collect their own data while carefully interpreting others’ data and their conclusions, but also access stored data to use in improving their practice. **Data mining** in education refers to exploring sources of raw data (data not yet processed) to learn more about the teaching and learning process. Many ways of investigating unique types of raw data exist in education, each having potential use for teachers, counselors, administrators, and students themselves.

Data mining can be done in the classroom, school, district, and beyond. An enormous amount of data exist at the national level, such as National Assessment of Educational Progress (NAEP) achievement scores and high school graduation rates. But can these data be managed, organized, and “dredged” in ways that suggest informative changes in learning settings? The answer is a resounding Yes when the data originate in the classroom. An example of data mining is analysis that reveals factors associated with significant gains or losses on standardized achievement tests: Are large discrepancies first noticeable in the third grade? Are large gains linked to a specific curriculum? Does attendance correlate with achievement? Is attendance related to achievement gaps among students? What factors moderate—alter—this relationship? Although the primary goal of data mining is improving educational practice and student learning, not testing theory, it is likely that patterns in the data will emerge to spawn new theories or revise old ones.

Data Mining in the Classroom

Let’s look at a hypothetical example of data mining in the classroom. Mrs. Ricardo accesses and analyzes an expanding data set that she generates by collecting pretest knowledge scores before beginning a four-week unit in math. She has collected these data for years and stores them unanalyzed on her computer. Can they be transformed in ways that guide her instruction and improve learning?

She pulls up her data from last semester. Consider 18 students’ pretest scores (1 or 0 for right or wrong) on five items as well as the total score as shown below (ignore final scores for the moment):

Item					Pretest Total	Final
1	2	3	4	5		
1	1	0	1	0	3	1
0	0	0	1	0	1	0
1	1	1	1	1	5	1
1	0	0	0	1	2	0
0	0	0	0	0	0	0
1	0	1	1	0	3	1
1	1	1	1	0	4	1
1	1	1	1	1	5	1
0	0	1	1	1	3	0
1	0	0	0	0	1	0
1	1	1	1	1	5	1
0	0	0	0	0	0	0
0	0	0	1	1	2	0
1	1	1	1	0	4	1
1	1	0	1	0	3	1
1	1	0	0	0	2	0
1	0	0	0	0	1	0
1	1	0	0	0	2	0

Entering those data into a spreadsheet program such as Excel and correlating each item score (1 or 0) with the pretest total will produce useful information. (The correlation maneuver, available in Excel, is explained in Chapter 11, but for now, all you need to know is that the closer to 1.00 a correlation coefficient is, the stronger the link, or association, between variables being correlated.) The correlation matrix quickly reveals that item 3 has the strongest link to the pretest total score (correlation = .64), meaning those students who answered item 3 wrong *generally* scored lower on the pretest total and those who answered it correctly *generally* scored higher on the pretest total. Item 3, therefore, “predicts” the pretest total score better than any other item. In fact, if Mrs. Ricardo wants to create a one-item pretest, item 3 is the best single item to use. Because of the “power” of this single item to predict pretest total scores, it deserves close attention. It may contain an overarching concept that is especially important.

Because of these data, Mrs. Ricardo revises her instruction to take advantage of the key concept embedded in item 3, which she reasons should be ingrained in students’ understanding. She now teaches the important concept in multiple ways so that *all* students are more likely to become proficient in the principle the concept underlies, maximizing their preparation for the following unit.

Mrs. Ricardo can mine these data further by investigating how the pretest total correlates with the final assessment at the end of the unit, shown as Final in the far right column above (1 is pass; 0 is fail). She then uses her spreadsheet program to “cross tabulate” Pretest Total with Final, as shown below:

Pretest Total	Final (0 = fail; 1 = pass)	
	0	1
0	2	0
1	3	0
2	4	0
3	1	3
4	0	2
5	0	3

Inspection of this table reveals that *no student scoring less than 3 on the pretest total passed the final*. In the future, Mrs. Ricardo can set a “cutoff” score of 3, meaning that students scoring less than 3 will require more extensive review or remediation before beginning the unit.

Data Mining Beyond the Classroom

Data mining is valuable because it “puts data to work” beyond the classroom with routine applications in whole schools, districts, states, and regions. In “From Analysis to Action,” Sawchuk (2010) describes how one high school in Fall River, Massachusetts, accomplished analysis-to-action by examining markers of student disengagement (such as objective measures of absence, dropout, retention, and failure) and linking positive trends in those data with changes resulting from an analysis of direct communications with parents, faculty, and the students themselves. Problems with instruction in Advanced Placement (AP) classes became evident by transcript analysis showing that A and B grades were linked to failures on the

Advanced Placement exams. (The AP average was 1.4 on a 1 to 5 scale with 3 as passing.) This finding was a clear call to action for the high school and resulted in replacing “grade inflation” with academic rigor.

Whiting (2006) described whole-district data mining in Lafourche, Louisiana, in an effort to understand the causes and consequences of students’ disciplinary problems and school effectiveness in preventing further misbehavior. The 33,000 disciplinary reports included a written description (narrative) of incidents and school responses. This type of qualitative data was a challenge to analyze, but the “data miner” wanted to “stop looking at anecdotal evidence and start looking at actual data patterns” (para. 1). Text analysis software can search and categorize key words, the goal being to learn about hidden factors not apparent to the casual observer, including patterns that might link the type of infraction (e.g., use of foul language) with student characteristics or subgroup classifications. Repeated violations may also be associated with specific school responses (e.g., detention), shedding light on the effectiveness of various school interventions and whether all students are treated fairly. Uncovering reliable connections, such as the association of one type of intervention with more positive outcomes, is simply not possible without objective analysis of a large pool of information (data). A single case of infraction and disciplinary action may make a memorable and influential story, but it may not result in more effective and fairer policies.

Cohen (2003) provided another example of district data “warehousing,” “drilling,” and mining “to improve teaching,” this time in New York. Starting with the assumption (with empirical support) that the teacher is the most potent factor influencing student learning, Cohen compiled multiple sources of data generated over time (longitudinal data, meaning data accumulated over several years for the same teachers and students) with the goal of uncovering “credible connections” (p. 53) between teaching effectiveness and student learning (teacher-to-teacher comparisons). What teaching styles and strategies consistently yielded higher student performance? A single teacher’s matrix might include scores on the state standardized exams, course grades, course exam scores, number of students, and student performance markers from previous years—all compared to whole-school, whole-district, similar-schools, county, and state data. Using “careful reflection” (p. 55) and powerful tools to reconfigure the data, Cohen found that specific teachers popped out as being more (or less) effective. The amount of data, including student achievement trends over time, allowed careful consideration of alternative explanations (e.g., teachers having larger classes and lower-achieving students) before judgments of teacher effectiveness were made. The overarching goal was to discover methods of the most effective teachers in order to help less effective ones in an effort to improve instruction overall.

Given a sufficient number of teachers, it is also possible to learn whether a specific teaching method is associated with better performance among lower-achieving, average, or higher-achieving students. The same spirit of inquiry can be used, of course, to target specific students at risk for failing (via trajectory or forecast graphs) with the goal of creating a program that averts this outcome.

National data sets also reveal the power of data mining. Swanson (2010) describes how “21 urban districts beat the odds” (p. 26) in our nation’s graduation rates. Graduation rates at the district level can be predicted in a statistical procedure by knowledge of such factors as size, urban versus rural, spending, and racial and socioeconomic measures. By comparing the predicted graduation rate with the actual graduation rate, one can identify districts that outperform—or underperform—their statistical prediction. Further study of these overperforming and underperforming districts can reveal factors that distinguish them from the others. What are overperforming schools doing right? Follow-up study may reveal, for

example, differences in vocational programs, courses in the visual arts, physical education, or counselors per student.

Educators are also discovering the value of ancillary pieces of test data known as *data exhaust*. These are digitized sources of information that surround a test score and are collected during administration of the test. Examples include time spent on a single item, changed answers, skipped questions, total time spent, the point at which responses appeared random, and other similar sources of data that reflect testing behavior. Analysis of data exhaust may reveal information useful in the interpretation of an overall test score. There are clear teaching implications when specific test items consume excessive time (not linked to faulty item construction but to students' conceptual confusion) or when there is consistency across test takers who “fall off track” when specific content is assessed.

Data mining in education is a clear recognition that data—from classroom data to massive amounts of data at the state or national level—yield no information about student learning or directions for adjustment without analysis. Reconfigured data that reveal relationships or patterns with clear implications for practice have great potential in schools and other workplaces. The tools and resources for data mining are available to many practitioners. School personnel may become data experts with programs as accessible as XLMiner, available in later versions of Excel as an add-in.

Qualitative Research and Data Mining

Educational data take many forms, both qualitative (text, video, etc.) and quantitative (statistical). You will learn more about interviewing and observing, common qualitative sources of data, in Chapter 12. Merriam (2009) reveals many procedures for “mining data from documents” and reminds us that great variation in written, visual, digital, and physical objects (also called *artifacts*) are available to researchers for mining. Documents are numerous and include diaries, public records, correspondence, media reports, and visual products such as photographs. Physical material can also be mined, including garbage (Rathje & Murphy, 2001), having the advantage of yielding evidence of actual, not reported, behavior. School documents provide evidence of, for example, school climate or parental involvement. Online or digitized sources of data (e.g., students' e-mail or websites) also provide sources of information not easily gathered elsewhere.

Given the sheer volume of digitized data, it seems reasonable that many qualitative research studies will mine text-rich sources potentially related to educational practices and learner characteristics, such as online discussion groups or forums, policy statements, transcripts, and writing samples. Online data access, collection, and analysis, however, presents challenging ethical dilemmas and safeguards, a topic explored in Chapter 4.

AVOID BEING SNOOKERED

Being misled when reading research findings is common unless one is capable of “detecting and correcting the lies that data tell,” as Schmidt (2010) noted in the title of his article. The problem has been especially pronounced in education in recent years, given the “politicalization” of reform efforts (e.g., No Child Left Behind) and the propaganda surrounding it (Henig, 2008/2009).

But there are champions in the cause for disentangling propaganda masquerading as “research.” Gerald Bracey was one such champion in education, intent on informing readers

how to avoid being fooled (“snookered”) while reading educational research (Bracey, 2006). To that end, he offered 32 “principles of data interpretation,” many related to misconceptions about measurement in education. All are directed toward achieving clarity via critical thinking and avoiding twisted paths that lead only to misunderstanding. Unfortunately, as Bracey notes, most people simply accept research claims because they lack information to challenge them. Being an expert in research and statistics is not a requirement for critical thinking about research—a few basic principles go a long way.

Here is an adapted summary of several recommendations offered by Bracey (2006) for readers of research, with explanations in the paragraphs that follow.

Beware of:

- Claims with no data
- Selectivity in choice of data
- Noncomparable comparison groups
- Simple explanations
- Rates confused with numbers or scores
- Statistical versus practical importance
- Causal interpretations from correlational findings
- Rising scores interpreted as rising achievement

Claims With No Data

Different opinionated claims abound in the heated teacher preparation debate. For instance, which is better for education: traditional college or university certification or alternative routes such as Teach for America? If I heard the assertion that alternative routes are degrading the profession and place many unqualified teachers in the classroom, undermining their students’ achievement, I would ask to see data. What do empirical studies reveal? The data are in and available from the National Research Council (2010).

Prominent scholars examined the best available evidence over six years and concluded that no evidence exists in favor of either approach: “We found no evidence that any one pathway into teaching is the best way to attract and prepare desirable candidates and guide them into the teaching force” (p. 2). With no favorite path, the data suggest a “draw.” The panel did find, however, overwhelming evidence that teachers make a difference. Their content knowledge and pedagogical skills—whether they were conventionally trained or not—are important characteristics clearly linked to learning outcomes. The point: Seek data before accepting a claim as being true.

Selectivity in Choice of Data

Consider Drug Abuse Resistance Education (D.A.R.E.), police-based lessons that focus on young students’ ability to resist peer pressure to use drugs. From their website (www.dare.com), we learn that D.A.R.E. “has proven so successful that it is now being implemented in 75 percent of our nation’s school districts and in more than 43 countries around the world” (D.A.R.E., n.d., para. 2). The “proven success” appears to be based on very selective data (namely, Carnevale Associates, n.d., an unpublished, non-peer-reviewed evaluation study). By contrast, the vast majority of representative empirical studies and published reviews reveal a very different conclusion (e.g., Pan & Bai, 2009; United States General Accounting Office, 2003). The point: Seek credible research that is representative of answers to the research question asked.

Noncomparable Comparison Groups

Consider one study focused on the influence of charter high schools' graduation and going-to-college rates (Booker, Sass, Gill, & Zimmer, 2010). Their conclusion was unambiguous: "New evidence suggests [charter schools] are boosting high school graduation and college attendance rates" (p. 71). But are they? Are the charter school students comparable to the traditional high school students? Might their choice to stay enrolled in charter schools until graduation simply mean they are more highly motivated students to begin with, given that they sought charter schools? (And could they possibly have had even *higher* rates if they attended a conventional high school?) Might this motivational difference, if it exists, explain their higher graduation and colleges rates even if the charter experience had no influence? The answers to those questions are not known (reminding us about the interpretational difficulties of "apples and oranges").

Only a true experiment with students randomly assigned to charter versus conventional schools would help to answer those questions. Notice the careful wording in the researchers' conclusion: "We find that charter schools are *associated* [emphasis added] with an increased likelihood of successful high-school completion and an increased likelihood of enrollment at a two- or four-year college . . ." (Booker et al., 2010, p. 75). They were careful not to make direct causal connections, given the noncomparable groups. Further, they recognized the noncomparability problem by statistically equating important variables such as ethnicity and family income. They also met the motivation issue head on by selecting eighth-grade *charter* students who chose either a conventional or a charter high school. Thus, all were "charter choosers" (hence matched to some extent), but the fact remains that the students *selected* their high school, and therefore may have also been different in other ways that were causally connected to positive outcomes. One control for such problems is "lottery losing," the situation that arises when there are too many students seeking charter schools (or some other alternative) than can be accepted. Charter school students are selected by a random method, hence creating a "loser" group (attending a traditional school) that may or may not be comparable to the charter group. (Dramatic illustrations of the "lottery loser" phenomenon are portrayed in the film *Waiting for Superman* [Chilcott & Guggenheim, 2010]) At the middle school level, findings from studies using lottery methodology reveal that "on average, charter middle schools that hold lotteries are neither more nor less successful than traditional public schools in improving student achievement, behavior, and school progress" (United States Department of Education, 2010, p. xvii). The point: Be alert to group comparison studies that risk differences other than the classification—the presumed cause.

Simple Explanations

Kalist and Lee (2009) conducted a study that revealed unpopular names (e.g., Ernest) are correlated with criminal activity, whereas popular names (e.g., Michael) are associated with less crime. How is this possible? A simple explanation offered by the researchers is that the name itself is causal: ". . . juveniles with unpopular names may be more prone to crime *because* [emphasis added] they are treated differently by their peers, making it more difficult for them to form relationships" (p. 41). Presumably, this will somehow translate into greater propensity for juvenile delinquency. Other simple explanations are suggested, including that because "some employers may discriminate against job applicants with unpopular names, juveniles with these names may have fewer employment opportunities and thus they may turn to crime" (p. 41).

To explain why a higher proportion of juvenile delinquents have unpopular names, regardless of race, the researchers also recognized complexity in the form of co-occurring variables such as socioeconomic resources and the home and neighborhood environment. The name-crime link, if reliable, is undoubtedly explained by reference to a broader social context and a complex interplay with other factors associated with criminal activity. The point: Although simple explanations are often desirable (think of Occam's razor), many research-based socio-cultural relationships, including those in education, reflect complex interrelationships that deserve careful unraveling.

Rates Confused With Numbers or Scores

The term *rate* is used widely in our society and is part of everyday language. We refer to the crime rate, unemployment rate, interest rate, exchange rate, birth rate, literacy rate, and hundreds of others. Yet perhaps few know the precise meaning of the term with reference to statistical operations that yield the actual rate. Rate is a fraction of some sort, determined by values in the numerator and denominator.

Rates may be calculated from test scores showing the rate of growth, or they may be numbers of students exceeding the cut score on a test. The calculation of achievement gaps in education, for example, may suggest a decreasing trend or a widening trend, depending on values within the fraction. In a dramatic example, Isaacson (2007) reported on “amazing Mississippi,” where a “proficiency” rate among fourth-grade readers was 89% using their own set standard. This was rank 1 in the nation. Yet a sample of fourth graders completing the NAEP revealed that only 18% were “proficient”—a rank of 50. It is unclear, based on passing rates and proficiency cut scores, whether Mississippi was the highest or lowest in the nation at the time of testing—or somewhere in the middle.

For another dramatic example, consider the high school dropout rate, capable of wide variation depending on definitions and political purposes. The dropout rate, incredibly, has even been calculated using a dropout's *promise* to obtain a GED sometime in the future (giving the individual status as a “graduate,” not a dropout; United States Department of Education, 2008). Further, the “Texas Miracle,” a claim that high-stakes testing led to increased achievement scores and lower dropout rates—*even zero*—was debunked by Haney (2000) and explained, in part, by manipulation of rates and scores. The point: Attend to the calculation of statistics such as rates, given the variation (or creativity) in their calculation.

Statistical Versus Practical Importance

The word *significant* has a long history of confusion and controversy in the social sciences. When researchers report that a research finding is “significant,” they are usually using a shortened version of “statistically significant,” a concept referring to the likelihood that chance factors explain the results obtained in the sample. Specifically, it is interpreted as a low likelihood (less than 1 out of 20) that a sample statistic (e.g., an observed mean difference) represents a population characteristic presumed to have no difference, given a specific sample size and an assumption that the sample truly reflects the population. More informally, statistically significant means that the obtained research finding cannot easily be dismissed as chance.

This is informative, to be sure, yet it ignores other important information about the research finding, namely, the magnitude of the relationship found in the sample (called “effect size”). Statistical significance is affected by, among other factors, the size of the sample;

therefore, a statistically significant finding may be small (e.g., a mean difference of 1 pound in weight loss between a treated and a control group). Whether a difference is of *practical* importance in education—one related to practice, such as revising instructional methods—depends on factors in a larger context. For example, the consensus among researchers is that the effect of commercial test prep and coaching programs on college admissions SAT scores is small (Briggs, 2009), about 30 points (total) on the math and verbal combined scores (range 400 to 1,600). (The test prep effect on the ACT is also small, perhaps 1 point in a scale of 1 to 36.) Will this make a difference in the outcome of college admission? The answer is not obvious (given cutoff scores), revealing that the evaluation of practical significance is affected by many real-world factors, including in this case the opinion of college admission officers. The point: Statistical significance is not equivalent to practical significance. Interpreting a research finding often requires information about the effect size.

Causal Interpretations From Correlational Findings

Readers of research in education need constant reminders that *correlation does not imply causation*. The rooster does not raise the sun. Much research in education is correlational, meaning variables are measured without intervention to determine whether there is an *association* between them. For example, a correlational study of class size and student achievement would begin by selecting perhaps 100 third-grade classes of varying size (say, from 12 to 30 students) across several large school districts. An achievement measure, such as a reading score on a standardized test, would then be statistically evaluated for its link to class size.

Let's presume this finding: Smaller classes were associated with higher achievement, larger classes with lower achievement. Does this mean that reducing class size will invariably increase student learning? No, for the simple reason there could be other factors that explain this correlation (more effective teachers are found in small classes; smaller classes use different instructional materials; smaller classes are located in wealthier districts with more resources; etc.). Simply because two variables are correlated does not mean that changing one will change the other. That interpretation is reasonable only after determining the relationship is causal, not merely correlational. This was precisely the goal of the famous Tennessee class size experiment, known as Project STAR, in the 1980s (follow-up known as the Lasting Benefits Study), whose findings were described by Nye, Hedges, and Konstantopoulos (2001).

As we shall see in later chapters, a true experiment involves random assignment of participants to groups that define an intervention or manipulation, such as varying class sizes. In the Project STAR experiment, kindergarten students in 79 schools (about 11,000 students) were assigned *randomly* to smaller versus larger classes and followed for four years. About 1,300 teachers were also assigned randomly to classes to eliminate the possibility of more qualified teachers' being associated with small classes (ensuring a quality known as *internal validity*). Researchers analyzing Project STAR data found consistently positive results on achievement, suggesting a *causal* connection between class size and achievement. This warrants a *potential* recommendation to reduce class size with an expectation that higher achievement will result.

California took notice of the STAR experiment and began a large-scale program to reduce class size in the 1990s with the expected outcome of higher achievement. (Wisconsin also began a careful study of class size reduction in the 1990s with Project SAGE.) Although findings were promising for those advocating class size reduction, the complete picture that emerged later was mixed, complex, and “inconclusive” (Bohrnstedt & Stecher, 2002). The point: Findings based on a correlational study do not imply a cause-and-effect relationship.

Interpreting cause and effect is not the only problem associated with correlational findings. Correlations are easy to compute from readily accessible data, yet the more correlations computed, the more likely “significant” correlation is meaningless because of the working of chance. A table of random numbers will yield, on average, one statistically significant correlation by chance when 20 correlations are computed. Simply, the more correlational “fishing” one does, the more likely it is to confuse a “real” correlation with one that stems from chance. Blimling (2004) reminds us of this problem with “White Blankets Make You Smarter.” While reading the morning paper, he saw a report suggesting how college students could improve their GPA: Students who brought a white blanket to college had GPAs of 3.6 or higher, yet not a single student with a green blanket had similarly high GPAs. Those with stuffed animals were more likely to make the dean’s list, and so forth. Two cautions were in order: exchanging your green blanket for a white one and purchasing a stuffed animal would probably not raise your grades. The findings were likely reported correlations *among many computed correlations* that were significant by chance. (Blimling traced the source of the “research” to IKEA, a home furnishings company.)

Rising Scores Interpreted as Rising Achievement

Achievement test results presume that scores reflect learning, and a rising trend suggests that the results are meaningful and that achievement is increasing over time. But are those presumptions true? Think about alternative explanations. Might scores actually be reported as proficiency rates (see earlier), with ever changing passing scores warranting the label “proficient”? Are students becoming increasingly skillful at test preparation or mastering only the content known to be on the test (test drill opposed to authentic learning)? Are academically weaker students disappearing from the pool of students eligible for testing? (Weaker students may leave a district in search of alternatives, or districts may “excuse” certain populations that otherwise would have pulled down a school average.) Could outright fraud explain the rise? Nichols and Berliner (2007) provide other explanations for the “corrupted” validity of achievement test scores and remind us that conclusions about learning from achievement test scores may not be a reasonable inference. The point: Achievement trends may not reflect learning trends because factors unrelated to learning may explain the findings.

HIGHLIGHT AND LEARNING CHECK 1.9 AVOID BEING SNOOKERED

Readers with years of experience reading educational research and applying critical thinking will often lapse into uncritical acceptance of research findings and conclusions. They may forget, for example, that claims may have no empirical basis, data may be highly selective, and correlations may not reflect cause. Can you think of an overriding principle of research and data interpretation that applies to most of, if not all, the cautions expressed by Bracey in the preceding section? Is there an overriding critical thinking skill that might protect researchers from falling into the trap of misinterpreting data or reaching dubious conclusions?

CRITICAL THINKER ALERT 1.2 BEING SNOOKERED

Findings from data analysis in education can be interpreted in many ways. They are also subject to political bias, rendering them less useful because the interpretation may not match reality. Consider this claim: “Students’ achievement is linked to teachers’ verbal ability more than other teacher characteristics. This suggests teacher preparation programs should accept only those scoring high on the ACT or SAT verbal sections.”

Discussion: Evaluate this claim with regard to common pitfalls that permit the “snookering” of readers of research in education. What questions might you ask to avoid being snookered?

SUMMARY

Making educational research accessible is the goal of this book, and learning about research involves new ways of thinking. Researchers improve the quality of education by increasing their knowledge of the art and science of teaching and the process of learning. Practitioners acquire this knowledge by reading published research reports. Evaluating research enables one to make sound decisions about applying educational research to practice. Critical thinking about research is a developed skill. A thinking-skills approach to educational research views educators as reflective practitioners and teacher researchers as critical thinkers. Many educators' ideas about research are challenged by a deeper understanding of its process, and as a result, they begin to understand why research results can be so maddeningly contradictory and inconclusive. Critical thinkers understand that inconsistent or opposing research findings in education are largely a function of methodology—how research is designed and carried out. Other factors that explain research discrepancies are among the topics explored in the remaining chapters. We know that research improves education and that data mining is one approach to making sound, data-driven decisions. There are countless ways to become “snookered” by research reports and others' conclusions. Clear thinking about research findings and awareness of interpretational pitfalls enable astute readers of research to guard against being misled by propaganda and meaningless claims embedded in “bad science.”

KEY TERMS

Cherry picking	17	Critical thinking	6	Discrepant findings	16
Confirmation bias	7	Data mining	18	Reflective practice	12

APPLICATION EXERCISES

1. Visit the What Works Clearinghouse (WWC), “the trusted source for what works in education” (<http://ies.ed.gov/ncee/wwc/>). The WWC was founded in 2002 by the U.S. Department of Education's Institute of Education Sciences (IES) to provide a central source of information on program and practice effectiveness in education. It uses the most rigorous standards of scientific research applied to education in its evaluations and recommendations. You might also visit the RAND Corporation's Promising Practices Network (<http://www.promisingpractices.net/>), which also describes programs and practices that credible research suggests are effective in improving learning and outcomes for students and families. Because both sites are fully grounded in scientific evidence, the importance of this information can be linked directly to the value of research. What programs and practices described at one or both of these sites strike you as especially significant? Why? How do they highlight the value of research?
2. Using the same resources in your library or on the Internet, find two studies that present findings that contradict each other. Then try to explain how it is possible that the two studies yielded contradictory results. Hint: This is not as difficult as you might think. Two studies may be located by reading a third study in an area of interest. Authors who review previous research will often cite at the beginning of their article several studies revealing one outcome and several others revealing a different outcome. Choose one in each opposing group and examine the study differences carefully in an attempt to explain the opposition.

STUDENT STUDY SITE

Log on to the Web-based student study site at www.sagepub.com/suter2e for additional study tools including:

- eFlashcards
- Web Quizzes
- Web Resources
- Learning Objectives
- Links to SAGE Journal Articles
- Web Exercises

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