Building Expertise

Cognitive Methods for Training and Performance Improvement

Third Edition

Ruth Colvin Clark

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About This Book

Why Is *Building Expertise* Important?

This is a book about the psychology of expertise and how instructional professionals can leverage mental processes to grow expertise in the workforce.

Whether you are a class facilitator, course developer, or both, your job is to build expertise. There are many books available on the *how's* of training, full of useful tips and techniques. But for the most part, these books don't explain the *why's* behind the how's. Unlike what's in these books, I present guidelines based on how people learn and on evidence of what works during learning. What distinguishes a professional from a paraprofessional approach to education and training is a depth of understanding of how learning occurs and how to adapt evidence-based guidelines to unique situations.

What's New in the Third Edition?

In the 21st Century, the global economy has become a reality. To stay competitive, organizations must increasingly rely on innovation—innovation emerging from expertise that can be adapted to diverse and unpredictable contexts. Throughout this new edition, I draw on evidence about how to build innovative forms of expertise and translate that evidence into useful guidelines for instructional professionals.

I have rewritten all of the chapters that appeared in the second edition. In some cases, I divided chapters to reduce the mental load. In my rewrite, I updated the research on the various techniques discussed throughout the book. Since the second edition, we have seen growth in e-learning with expansions into synchronous as well as asynchronous delivery methods. I have incorporated new examples to reflect these changes.

Finally, this is the first time *Building Expertise* has benefited from a professional production effort. Newly published by Pfeiffer, this edition reflects professional editing and layout.

What Can You Achieve with This Book?

If you are a designer, developer, facilitator, or evaluator of instructional environments for classroom or digital delivery, you can use the guidelines in this book to

ensure that your courseware meets human psychological learning requirements. In particular you can learn the best ways to build expertise by:

- Reducing unproductive mental load during learning
- Directing attention
- Leveraging prior knowledge of your learners
- Helping learners build new mental models through implicit and explicit training methods
- Supporting transfer from the instructional environment to the workplace
- Using guided discovery design architectures that build problem-solving skills
- Building mental monitoring and learning management skills
- Motivating learners to invest the effort needed to build expertise

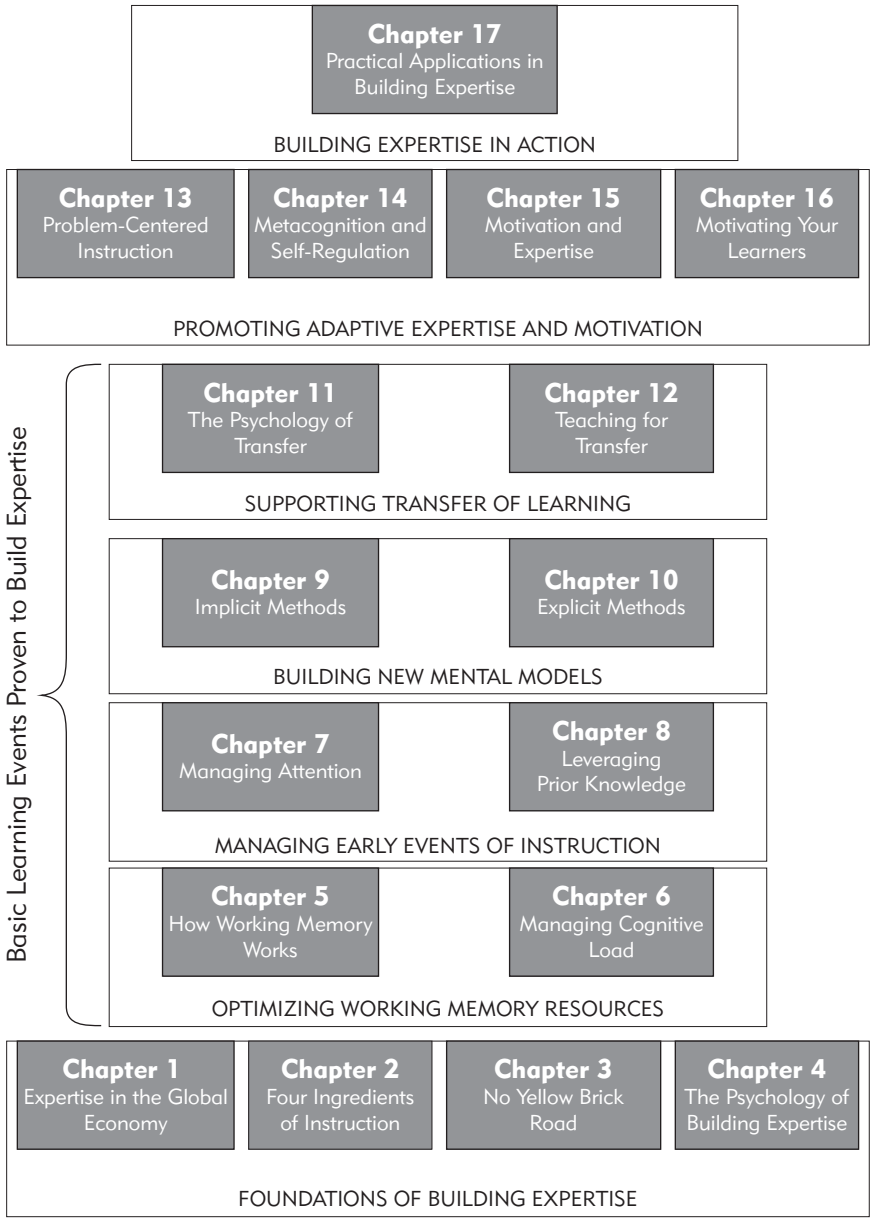
How Is This Book Organized?

From music to chess to programming, psychologists have learned a great deal by studying experts in various domains. Part I includes Chapters 1 through 4, which lay the foundation for the book by summarizing what recent research tells us about expertise—what it is and how it grows. These chapters introduce key concepts relevant to the rest of the book, including the features of expertise, four learning architectures, and an overview of how learning happens.

Part II is the heart of the book, containing eight chapters that focus on the core psychological learning events proven to build expertise. These chapters explain the psychology of each learning event and describe techniques to:

- Minimize unproductive mental load in working memory
- Support early events of instruction, including focus of attention and activation of prior knowledge
- Help learners build mental models through implicit and overt activities
- Create an environment that promotes transfer of learning to the workplace

Figure I.1. The Structure of Building Expertise



In Part III, I shift the focus to adaptive forms of expertise that are the basis for creative and critical thinking skills. In Chapter 13, you will learn about problem-centered learning environments that lead to adaptive expertise. In Chapter 14, I focus on how to build mental monitoring skills called metacognition. Finally, motivation fuels the engine that drives the effort required to build expertise. In Chapters 15 and 16, I look at recent research findings on instructional strategies you can use to promote optimal motivation.

The final chapter integrates the ideas of the book by describing instructional programs I have designed based on three of the instructional architectures introduced in Chapter 2 and summarizes guidelines for building adaptive forms of expertise through exploratory learning environments that encourage critical and creative thinking.

About Pfeiffer

Pfeiffer serves the professional development and hands-on resource needs of training and human resource practitioners and gives them products to do their jobs better. We deliver proven ideas and solutions from experts in HR development and HR management, and we offer effective and customizable tools to improve workplace performance. From novice to seasoned professional, Pfeiffer is the source you can trust to make yourself and your organization more successful.

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Building Expertise

Cognitive Methods for Training and Performance Improvement

Third Edition

Ruth Colvin Clark

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Introduction to the Third Edition

GETTING THE MOST FROM THIS RESOURCE

Purpose

Building expertise is the central challenge of all instructional practitioners. Yet few know the psychology or the evidence underlying training methods that lead to expertise. The training field is evolving from a craft based primarily on fads and folk wisdom to a profession that integrates evidence into the design and development of its products. A professional knows not only what to do but why she is doing it and how she might adjust techniques to accommodate different learners or diverse learning outcomes. Professionals can summarize the research behind their recommendations to their stakeholders. Because everyone who has gone to school considers him- or herself a learning expert, instructional practitioners face a unique challenge to establish themselves as professionals to their clients and their learners.

In this book you will learn techniques to build expertise. But just as important, you will learn the psychological reasons and the evidence for those techniques.

Audience

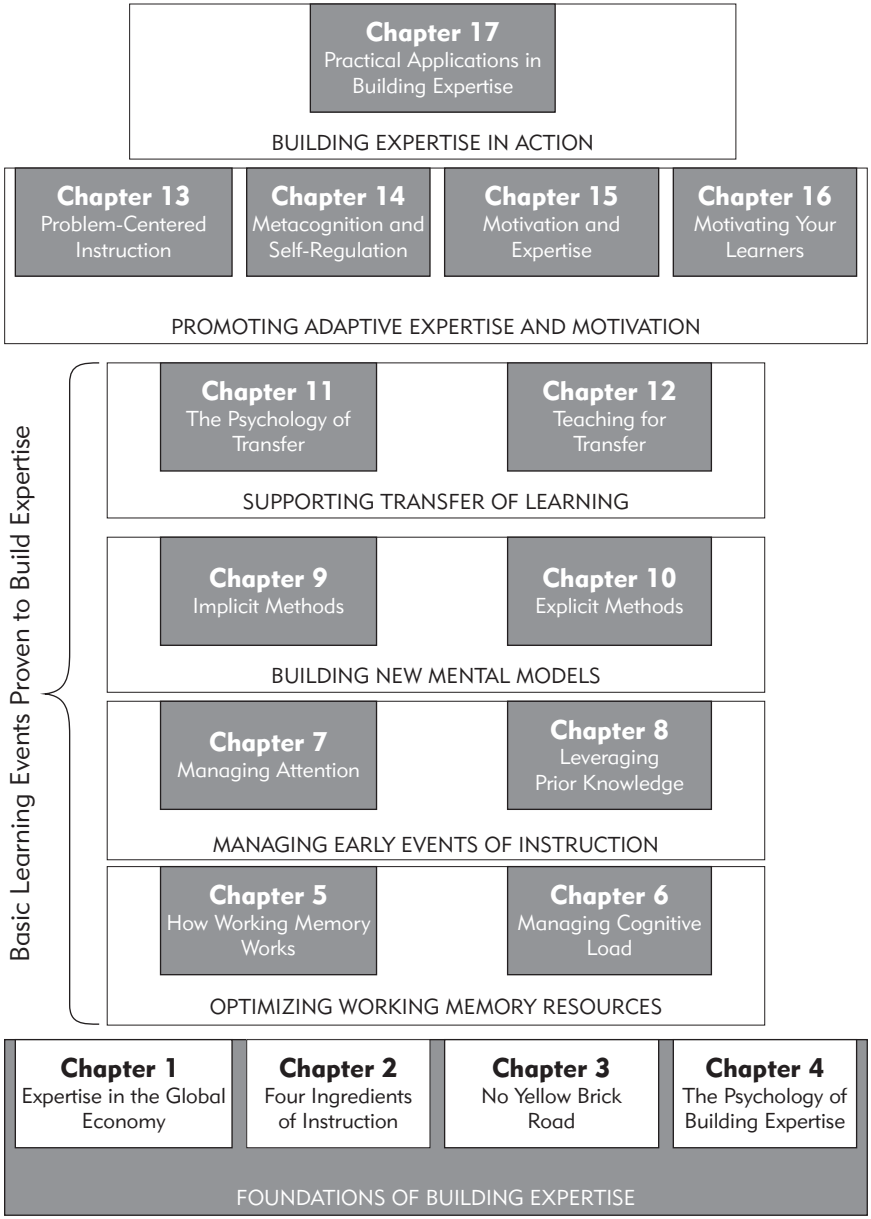
If you are a facilitator, designer, developer, evaluator, or consumer of training, you can use the guidelines in this book to identify learning environments that accelerate expertise. Although most of my examples are drawn from workforce learning, I believe that educational professionals can also benefit from these guidelines.

Package Components

The heart of the book is the seventeen chapters summarized in Figure I.1. Most chapters are organized around a pivotal psychological event involved in learning. These chapters summarize the psychology and illustrate training techniques that support each learning process. You will not only read about the techniques, but review evidence for them as well as application examples. At the end of each chapter you will find some references that offer more in-depth or technical information on the chapter topic.

Glossary

A glossary provides definitions of technical terms that appear throughout the book.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OPTIMIZING WORKING MEMORY RESOURCES
Chapter 1
Expertise in the Global Economy
Chapter 2
Four Ingredients of Instruction
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No Yellow Brick Road
Chapter 4
The Psychology of Building Expertise
FOUNDATIONS OF BUILDING EXPERTISE

PART ONE

Foundations of Building Expertise

HOW HAS the 21st Century global economy driven the need for adaptive forms of expertise that are the basis for innovation? What has recent research on experts from sports to medicine told us about how to efficiently grow expertise?

In Chapters 1 through 4 I lay the foundation for *Building Expertise* by summarizing recent research on expertise as well as describing the key ingredients and psychological events essential to any instructional program that supports expertise.

CHAPTER 1 TOPICS

The Value of Expertise

The Challenge of Global Expertise

What Is an Expert?

Seven Lessons Learned About Experts

1. Expertise Requires Extensive Practice
2. Expertise Is Domain Specific
3. Expertise Requires Deliberate Practice
4. Experts See with Different Eyes
5. Experts Can Get Stuck
6. Expertise Grows from Two Intelligences
7. Challenging Problems Require Diverse Expertise

1

Expertise in the Global Economy

An expert is a man who has made all the mistakes that can be made in a very narrow field

NEILS BOHR

WHAT IS AN EXPERT? How do people become experts? Is expertise a matter of talent or learning? What types of expertise are most needed in the new global economy? How can instructional professionals make use of what we know about experts to build more effective learning environments? This chapter sets the stage for the book by summarizing what we know about expert performance and why effective training programs are critical to organizations facing the competitive pressures of a growing global pool of expertise.

The Value of Expertise

If you have taken an airplane trip, consulted a medical professional, used computer systems, or attended a professional ball game or a concert, you have benefited from expertise! In fact, few

of us would get through a normal week were it not for the varied expertise that provides the infrastructure for our many daily activities. This is a book about expertise—specifically how to grow and deploy expertise most effectively to achieve organizational goals.

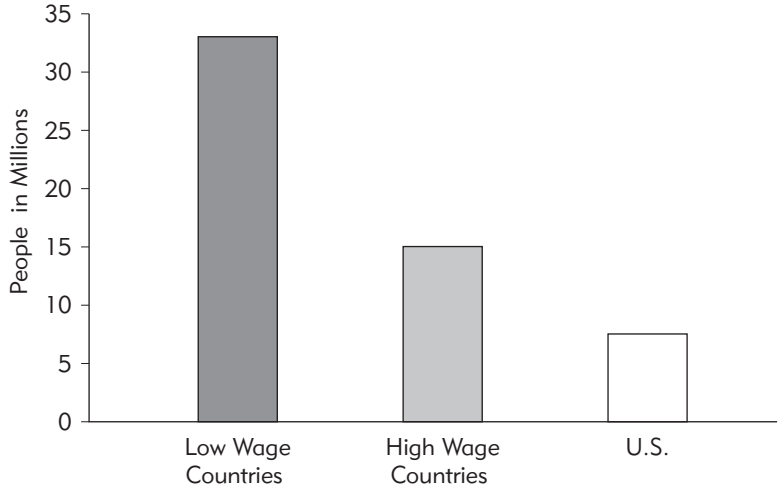
There is a large untapped reservoir of knowledge about how novices become experts and how that transition can be facilitated through training and other workplace solutions. In fact, as I write this third edition of Building Expertise, the research on expertise has grown sufficiently to warrant a new forty-two-chapter book: Cambridge Handbook of Expertise and Expert Performance, published in 2006! Knowledge about expertise is untapped in part because much of the recent research on human learning and expertise is buried in academic resources such as the Cambridge Handbook not routinely accessed by practitioners.

Instructional professionals like you who are responsible for the growth of expertise in your organization can benefit from this research. In other words, you need expertise on expertise. My objective in this book is to summarize the research and psychology about what we currently know about growing and leveraging expertise in organizational settings.

The Challenge of Global Expertise

Workers in developed countries face increasing global competition for expertise. Uhalde and Strohl (2006) estimate as many as forty million American jobs, equivalent to nearly a third of the U.S. labor force are theoretically vulnerable to off shoring. The expanding global pool for the type of higher level skills that have historically been the province of developed nations comes from the BRIC (Brazil, Russia, India, and China) supply chain. Since the turn of the century, 1.5 billion people from China, India and countries from the former Soviet bloc have joined the global labor force. Data from a 2005 McKinsey report summarized in Figure 1.1 show young professionals from low-wage countries, including engineers, finance analysts and accountants, and

Figure 1.1. Young Professionals in the Global Talent Pool, 2005
From McKinsey, 2005



generalists with university degrees make up the largest segment in the global talent pool. And foreign skilled professionals will continue to be inexpensive for several decades to come making some forms of expertise in Western workforces less competitive.

An organization's ability to innovate becomes the competitive edge in a global economy. "The need to innovate is growing stronger as innovation comes closer to being the sole means to survive and prosper in highly competitive and globalised economies" (David & Foray, 2003, p. 22). Therefore a recurrent theme in this book is the psychology of expertise—especially adaptive expertise that is the basis for creative and critical thinking.

What Is an Expert?

According to Wikipedia (2007), an expert is "someone widely recognized as a reliable source of technique or skill whose faculty for judging or deciding rightly, justly, or wisely is accorded

authority and status by the public or their peers. An expert, more generally, is a person with extensive knowledge or ability in a particular area of study". Wikipedia, one of a growing cadre of open-access software, did not exist at the writing of the second edition of this book and illustrates one way that expertise can be deployed through the Web 2.0.

Of course, expertise is not all or nothing. As one begins to learn a new set of skills, one evolves from novice through various skill levels up to expert or master performer. Table 1.1 summarizes the common labels and attributes associated with stages of expertise. As training professionals we encounter diverse levels of expertise in the course of our work. We may interview subject-matter experts who are, as the name implies, experts or even

Table 1.1. Levels of Expertise

Level	*An Individual Who*
Novice	Has minimal exposure to the field
Apprentice	Has completed a period of study beyond introductory level and is usually working in a domain under supervision
Journeyman	Can perform routine work unsupervised
Expert	Is highly regarded by peers; whose judgments are uncommonly accurate and reliable; whose performance shows both skill and economy of effort; and who can deal with unusual or tough cases
Master	Can teach others; a member of an elite group of experts whose judgments set regulations, standards or ideals

Based on Chi, 2006

master performers. Our learners are often at the novice or apprentice stages. Our training goals are often relatively modest in scope, perhaps to bring a novice closer to an apprentice level, or perhaps to teach a journeyman a new set of specialized skills or knowledge. As instructional professionals however, we are collectively responsible for the investment of close to $60 billion a year in the United States alone devoted to the growth of the specialized expertise that makes our organizations competitive (Industry Report, 2007).

Seven Lessons Learned About Experts

Psychologists have studied experts in a variety of domains, including sports, medicine, programming, music, and chess to see how they are different from less-skilled individuals. Here are the main lessons learned from that research:

1. Expertise Requires Extensive Practice

As you can see in Table 1.2 world-class experts start early in life and pursue their vocations through many years of prolonged and

Table 1.2. Years of Practice to Achieve World-Class Performance

Domain	*Starting Age*	*Years to International Performance*	*Age of Peak Performance*
Tennis	6.5	10+	18 to 20
Swimming	4.5	10	18 to 20
Piano	6	17	NA
Chess	10	14	30 to 40

Source: Ericsson, 1990

concentrated practice. While an acceptable level of performance in many tasks such as typing or tennis can be reached in a matter of a few weeks or months, high levels of expertise demand years of practice. Some of the first research focused on master-level chess players. About ten years of sustained chess practice is needed to reach master levels. In fact, from sports to music to programmers, the ten-year rule has proved pretty consistent. "Until most individuals recognize that sustained training and effort is a prerequisite for reaching expert levels of performance, they will continue to misattribute lesser achievement to the lack of natural gifts, and will thus fail to reach their own potential" (Ericsson, 2006, p. 699). In other words, while innate ability is one factor that contributes to expertise, most of us do not invest the level of practice needed to fully exploit the talents we have.

While most practice takes place on the job, as a trainer or instructional designer, you can leverage what we have learned about accelerating expertise through appropriate practice during training. For example, after twenty-five hours of study with a computer training simulator called Sherlock, learners with about two years of experience achieved a level of expertise that matched technicians with ten years of experience (Gott & Lesgold, 2000)! Acceleration of expertise can be achieved when training is designed on the basis of human psychological learning processes.

2. Expertise Is Domain Specific

Because someone is an expert chess player, will he or she be better prepared to solve a problem in physics? In general, the answer is no! Fields of expertise are very narrow. That's because expertise relies on a large body of *specific* knowledge accumulated over time in memory. Master-level chess players, for example, store over 50,000 chess plays in memory (Simon & Gilmartin, 1973).

These play patterns were acquired gradually over a ten-year period. Successful programmers solve new programming problems by drawing on specific programming strategies that have worked for them in the past.

Studies of expert performers show that concrete and specific knowledge stored in memory is the basis for expertise. Each job domain will require a unique knowledge base and a specialized educational and developmental program to build it. When it comes to high levels of expertise, there are no generic or quick fixes!

3. Expertise Requires Deliberate Practice

Although a long period of practice is needed, not everyone who invests a great deal of practice time will achieve high proficiency levels. We are all familiar with the recreational golfer who spends many hours playing, but never really moves beyond a plateau of acceptable performance. Ericsson (2006) distinguishes between *routine practice* and *deliberate practice*. For example, he found that all expert violinists spent over fifty hours a week on music activities. But the best violinists spent more time per week on activities that had been *specifically tailored* to improve their performance. Typically, their teachers identified specific areas of need and set up practice sessions for them. "The core assumption of deliberate practice is that expert performance is acquired gradually and that effective improvement of performance requires the opportunity to find suitable training tasks that the performer can master sequentially. . . . typically monitored by a teacher or coach" (Ericsson, 2006, p. 692). Deliberate practice requires good performers to concentrate on specific skills that are just beyond their current proficiency levels.

4. Experts See with Different Eyes

A profession that relies on visual discrimination such as radiology provides a salient example of seeing with different eyes.

Even experienced physicians rely on the unique expertise of the radiologist to review various forms of medical imagery and provide interpretations However, experts from all domains "see" the problems they face in their domains with different eyes than those with less experience. A programmer looking at code, a chess player viewing a mid-play board, or an orchestral conductor scanning the musical notation and hearing the symphony—all take in relevant data and represent it in ways that are unique to their expertise. As a result of their unique representations, they can choose the most appropriate strategies to solve problems or improve performance. Part of building expertise is to train the brain to "see" problems through the eyes of an expert; in other words, to build the ability to represent problems in ways that lead to effective solutions.

5. Experts Can Get Stuck

While expert performance is very powerful, expertise has its down sides. For example, based on their extensive experience, experts can be inflexible; they can have trouble adapting to new problems—problems that will not be solved by the expert's well-formed mental models. Bias is a facet of inflexibility. In presenting hematology cases or cardiology cases to medical specialists such as hematologists, cardiologists, and infectious disease specialists, Chi (2006) reports that specialists tended to generate hypotheses that corresponded to their field of expertise *whether warranted or not.*"This tendency to generate diagnoses about which they have more knowledge clearly can cause greater errors" (p. 27).

An advantage of any organization competing in a global talent pool is innovative and creative expertise. Uhalde and Strohl (2006) point to thinking and reasoning competencies including critical thinking, originality, innovation, inductive and deductive reasoning, and complex problem solving as critical to the new economy. Therefore, seeking ways to build flexible expertise that is the source of innovation is an increasingly important goal.