CONTENTS

Acknowledgments xvii

Introduction 1

e-Learning: Promise and Pitfalls 7
 Chapter Summary 7
 What Is e-Learning? 8
 Is e-Learning Better? 11
 The Promises of e-Learning 14
 The Pitfalls of e-Learning 18
 Inform and Perform e-Learning Goals 19
 e-Learning Architectures 20
 What Is Effective e-Courseware? 22
 Learning in e-Learning 24

ix

2. How Do People Learn from e-Courses? 29
Chapter Summary 29
How Do People Learn? 31
Managing Limited Cognitive Resources During Learning 36
How e-Lessons Affect Human Learning 39
What We Don't Know About Learning 44

3 Evidence-Based Practice 49

Chapter Summary 49 What Is Evidence-Based Practice? 50 Three Approaches to Research on Instructional Effectiveness 51 What to Look for in Experimental Comparisons 55 How to Interpret Research Statistics 57 How Can You Identify Relevant Research? 59 Boundary Conditions in Experimental Comparisons 60 Practical Versus Theoretical Research 61 What We Don't Know About Evidence-Based Practice 62

4 Applying the Multimedia Principle: Use Words and Graphics Rather Than Words Alone 67

Chapter Summary 67 Do Visuals Make a Difference? 69 Multimedia Principle: Include Both Words and Graphics 70 Some Ways to Use Graphics to Promote Learning 74 Psychological Reasons for the Multimedia Principle 76 Evidence for Using Words and Pictures 77 The Multimedia Principle Works Best for Novices 80 Should You Change Static Illustrations into Animations? 81 What We Don't Know About Visuals 84

5 Applying the Contiguity Principle: Align Words to Corresponding Graphics 89

Chapter Summary 89 Principle 1: Place Printed Words Near Corresponding Graphics 91 Violations of Contiguity Principle 1 94
Psychological Reasons for Contiguity Principle 1 99
Evidence for Contiguity Principle 1 100
Principle 2: Synchronize Spoken Words with Corresponding Graphics 104
Violations of Contiguity Principle 2 105
Psychological Reasons for Contiguity Principle 2 107
Evidence for Contiguity Principle 2 107
What We Don't Know About Contiguity 108

6 Applying the Modality Principle: Present Words as Audio Narration Rather Than On-Screen Text 113 Chapter Summary 113

Modality Principle: Present Words as Speech Rather Than On-Screen Text 115

Limitations to the Modality Principle 117 Psychological Reasons for the Modality Principle 119 Evidence for Using Spoken Rather Than Printed Text 121 When the Modality Principle Applies 126 What We Don't Know About Modality 127

7 Applying the Redundancy Principle: Explain Visuals with Words in Audio or Text But Not Both 131

Chapter Summary 131 Principle 1: Do Not Add On-Screen Text to Narrated

Graphics 133

Psychological Reasons for the Redundancy Principle 135 Evidence for Omitting Redundant On-Screen Text 137 Principle 2: Consider Adding On-Screen Text to Narration in Special Situations 139

Psychological Reasons for Exceptions to the Redundancy Principle 140

Evidence for Including Redundant On-Screen Text 142 What We Don't Know About Redundancy 144 8 Applying the Coherence Principle: Adding Extra Material Can Hurt Learning 151

Chapter Summary 151

Principle 1: Avoid e-Lessons with Extraneous Words 153 Psychological Reasons to Avoid Extraneous Words in e-Learning 155 Evidence for Omitting Extraneous Words Added for Interest 156 Evidence for Omitting Extraneous Words Added to Expand on Key Ideas 158

Evidence for Omitting Extraneous Words Added for Technical Depth 159

Principle 2: Avoid e-Lessons with Extraneous Graphics 159 Psychological Reasons to Avoid Extraneous Graphics in e-Learning 161

Evidence for Omitting Extraneous Graphics Added for Interest 162 Evidence for Using Simpler Visuals 165 Can Interesting Graphics Ever Be Helpful? 167 Principle 3: Avoid e-Lessons with Extraneous Audio 168 Psychological Reasons to Avoid Extraneous Audio in e-Learning 170 Evidence for Omitting Extraneous Audio 170 What We Don't Know About Coherence 172

9 Applying the Personalization and Embodiment Principles: Use Conversational Style, Polite Wording, Human Voice, and Virtual Coaches 179

Chapter Summary 179

Personalization Principle: Use Conversational Rather Than Formal Style, Polite Wording Rather Than Direct Wording, and Human Voice Rather Than Machine Voice 182
Psychological Reasons for the Personalization Principle 183
Promote Personalization Through Conversational Style 185
Promote Personalization Through Polite Speech 187
Promote Personalization Through Voice Quality 189
Embodiment Principle: Use Effective On-Screen Coaches to Promote Learning 189

What We Don't Know About Personalization and Embodiment 197

10 Applying the Segmenting and Pretraining Principles: Managing Complexity by Breaking a Lesson into Parts 201 Chapter Summary 201 Segmenting Principle: Break a Continuous Lesson into Bite-Size Segments 203 Psychological Reasons for the Segmenting Principle 206 Evidence for Breaking a Continuous Lesson into Bite-Size Segments 207 Pretraining Principle: Ensure That Learners Know the Names and Characteristics of Key Concepts 209 Psychological Reasons for the Pretraining Principle 210 Evidence for Providing Pretraining in Key Concepts 212 What We Don't Know About Segmenting and Pretraining 214 11 Engagement in e-Learning 219 Chapter Summary 219 What Is Engagement? 221 When Behavioral Engagement Impedes Learning 224 Engagement That Leads to Generative Processing 226 A New View of Engagement 233 What We Don't Know About Engagement 233 12 Leveraging Examples in e-Learning 239

Chapter Summary 239 What Are Worked Examples? 240 The Psychology of Worked Examples 243 Evidence for the Benefits of Worked Examples 243 Principles to Optimize Benefits of Worked Examples 245 Principle 1: Provide Worked Examples in Lieu of Problem Assignments When the Essential Load of the Lesson Is High 246 Principle 2: Fade from Worked Examples to Problems 247 Principle 3: Promote Self-Explanations 249 Principle 4: Include Instructional Explanations of Worked Examples in Some Situations 252 Principle 5: Apply Multimedia Principles to Examples 252 Principle 6: Support Far Transfer 256 What We Don't Know About Worked Examples 260

13 Does Practice Make Perfect? 265

Chapter Summary 265 What Is Practice in e-Learning? 267 Is Practice a Good Investment? 270 Principle 1: Add Sufficient Practice Interactions to e-Learning to Achieve the Objective 271 Principle 2: Mirror the Job 275 Principle 3: Provide Effective Feedback 275 Principle 4: Distribute and Mix Practice Among Learning Events 281 Principle 5: Apply Multimedia Principles 285 What We Don't Know About Practice 287

14 Learning Together Virtually 293

Chapter Summary 292 What Is Collaborative Learning? 295 What Is Computer-Supported Collaborative Learning (CSCL)? 297

Principle 1: Consider Collaborative Assignments for Challenging Tasks 302

Principle 2: Optimize Group Size, Composition, and Interdependence 304

Principle 3: Match Synchronous and Asynchronous Assignments to the Collaborative Goal 305

Principle 4: Use Collaborative Tool Features That Optimize Team Processes and Products 307

Principle 5: Maximize Social Presence in Online Collaborative Environments 308

Principle 6: Use Structured Collaboration Processes to Optimize Team Outcomes 309

What We Don't Know About Collaborative Learning 311

Chapter Summary 317 Learner Control Versus Program Control 319 Do Learners Make Good Instructional Decisions? 323 Principle 1: Give Experienced Learners Control 327 Principle 2: Make Important Instructional Events the Default 328 Principle 3: Consider Alternative Forms of Learner Control 330 Principle 4: Give Pacing Control to All Learners 331 Principle 5: Offer Navigational Support in Hypermedia Environments 332 The Bottom Line 335 What We Don't Know About Learner Control 335 16 e-Learning to Build Thinking Skills 341 Chapter Summary 341 What Are Thinking Skills? 343 Can Thinking Skills Be Trained? 347 Principle 1: Focus on Explicit Teaching of Job-Relevant Thinking Skills 349 Principle 2: Design Lessons Around Authentic Work Tasks or Problems 353 Evidence for Problem-Focused Instruction 358 Principle 3: Define Job-Specific Thinking Processes 361 What We Don't Know About Teaching Thinking Skills 363 17 Learning with Computer Games 369 Chapter Summary 369 Do Games Have a Place in the Serious Business of Training? 371 Which Features Improve a Game's Effectiveness? 372 Does Game Playing Improve Cognitive Skills? 377

15 Who's in Control? Guidelines for e-Learning Navigation 317

Are Games More Effective Than Conventional Media? 382

What We Don't Know About Learning with

Computer Games 385

18 Applying the Guidelines 391

Chapter Summary 391

Applying the Evidence-Based Guidelines to e-Courses 391 e-Lesson Guidelines Checklist 396 Review of Sample 1: Excel for Small Business 401 Review of Sample 2: Synchronous Excel Lesson 406 Review of Sample 3: Automotive Troubleshooting Simulation 409 Reflections on Past Predictions 411 Beyond 2016 in Multimedia Research 413

References 419

Glossary 451

List of Tables and Figures 473

Name Index 485

Subject Index 493

About the Authors 509