

1

e-Learning

PROMISE AND PITFALLS

WHAT'S NEW IN THIS CHAPTER?

IN THIS CHAPTER we define e-learning as training delivered on a digital device such as a smart phone or a laptop computer that is designed to support individual learning or organizational performance goals. Our scope includes asynchronous forms of e-learning designed for self-study as well as synchronous instructor-led e-learning. Among these two forms of e-learning, we include e-courses developed primarily to provide information (that is, inform courses) as well as those designed to build specific job-related skills (that is, perform courses).

In the five years since we wrote the second edition of *e-Learning and the Science of Instruction*, digital technology has continued to evolve rapidly. Web 2.0 shatters the traditional model of unidirectional instruction by supporting online multilateral exchanges of visuals, text, and audio within and outside of the learning community. Search engines such as Google, coupled with social media such as Facebook and YouTube, make learners receivers, producers, and

distributors of knowledge. Technology has also become more immersive in other ways. Three-dimensional worlds, made popular by gaming applications offer environments in which learners assume an avatar persona and can move around and interact with objects and other participants. Likewise, platforms have shrunk and diversified, giving birth to a range of mobile learning devices.

However, the benefits gained from these new technologies will depend on the extent to which they are used in ways compatible with human cognitive learning processes. When technophiles become so excited about cutting-edge technology that they ignore human mental limitations, they may not be able to leverage technology in ways that support learning. Instructional methods that support rather than defeat human learning processes are an essential ingredient of all effective e-learning courseware. The most appropriate methods depend on the goals of the training (for example, to inform or to perform); the learners' related skills (for example, whether they are familiar with or new to the skills); and various environmental factors, including technological, cultural, and pragmatic constraints.

In this chapter we lay the groundwork for the book by defining e-learning and identifying both the potential and the pitfalls of digital training. We also distinguish between inform and perform e-learning goals, introduce three e-learning design architectures and summarize key factors associated with effective courseware.

What Is e-Learning?

We define e-learning as instruction delivered on a digital device such as a computer or mobile device that is intended to support learning. The forms of e-learning we examine in this book have the following features:

- Stores and/or transmits lessons on CD-ROM, local internal or external memory, or servers on the Internet or intranet
- Includes content relevant to the learning objective
- Uses media elements such as words and pictures to deliver the content
- Uses instructional methods such as examples, practice, and feedback to promote learning

- May be instructor-led (synchronous e-learning) or designed for self-paced individual study (asynchronous e-learning)
- Helps learners build new knowledge and skills linked to individual learning goals or to improved organizational performance.

As you can see, this definition has several elements concerning the what, how, and why of e-learning.

What. e-learning courses include both content (that is, information) and instructional methods (that is, techniques) that help people learn the content.

How. e-learning courses are delivered via digital devices such as computers and smart phones using words in the form of spoken or printed text and pictures such as illustrations, photos, animation, or video. Some forms of e-learning called asynchronous e-learning are designed for individual self-study. We show a screen shot from an asynchronous class on Excel in Figure 1.1. These courses are typically self-paced, allowing individual learners to access

Figure 1.1. A Screen Capture from an Asynchronous Excel Lesson.

Using Spreadsheets in your Small Business
Lesson 2: Working with Formulas

Course Menu

Course Introduction

Naming Cells

Formulas

Copying Formulas

Absolute Cell Reference

Application Case Study

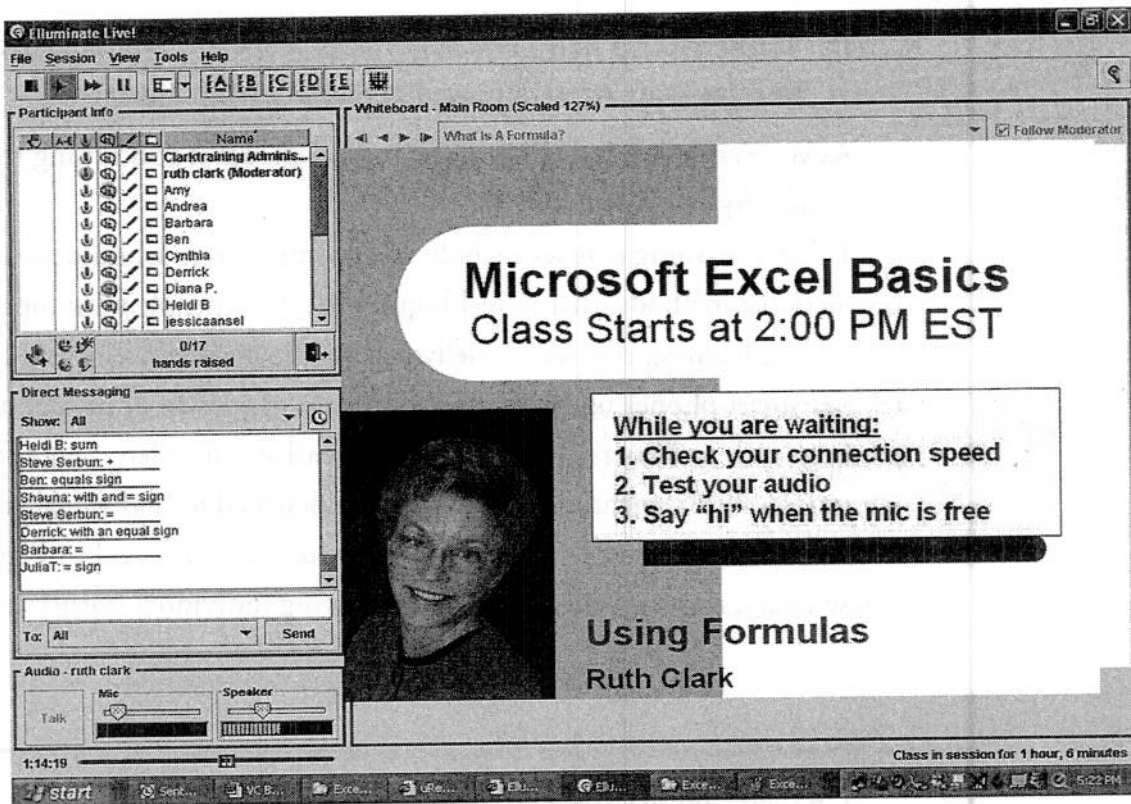
	A	B	C	D	E	F
1	Pete's Pet Emporium					
2						
3	Month	January	February	March	April	
4	Sales	\$60,000	\$84,000	\$80,000	\$92,000	
5	Overhead	\$40,000	\$32,000	\$35,000	\$45,000	
6	Profit	\$20,000				
7	Bonus percentage	=B6*.06				
8						
9						

Play >

All Excel formulas begin with an equal sign. Formulas also can include cell references, mathematical operators, and numbers. Using a cell reference allows you to quickly update your calculations when your data changes. Click on the play button on the spreadsheet above to see a short demonstration.

Audio ☒ Off ☐ On
< Previous Next >

Figure 1.2. A Screen Capture from a Synchronous Excel Lesson.



training at any time or any location on their own. Other formats called virtual classrooms, webinars, or synchronous e-learning are designed for real-time instructor-led training. We show a screen shot from a virtual classroom in Figure 1.2. Synchronous e-learning allows students from New York to New Delhi to attend an online class taught by an instructor in real time. However, synchronous sessions are also often recorded, allowing them to be viewed by a single learner in a self-paced manner. Synchronous and asynchronous forms of e-learning may support collaboration with others through tools such as wikis, YouTube, chat, discussion boards and email.

Why. e-learning lessons are intended to help learners reach personal learning objectives or perform their jobs in ways that improve the bottom-line goals of the organization.

In short, the “e” in e-learning refers to the “how”—the course is digitized so it can be stored in electronic form. The “learning” in e-learning refers

to the “what”—the course includes content and ways to help people learn it—and the “why”—refers to the purpose: to help individuals achieve educational goals or to help organizations build skills related to improved job performance.

Our definition states that the goal of e-learning is to build job-transferable knowledge and skills linked to organizational performance or to help individuals achieve personal learning goals. Although the guidelines we present throughout the book also apply to lessons designed for educational or general interest learning goals, our emphasis is on instructional programs that are built or purchased for workforce learning. To illustrate our guidelines we draw on actual training courseware from colleagues who have given us permission to use their examples. In addition we have built two sets of storyboards: one with a focus on basic Excel skills intended to illustrate a typical technology training course and a second with a focus on sales skills intended to illustrate instructional techniques that apply to more strategic skills.

Is e-Learning Better?

For many training goals, you may have a choice of several delivery media. One of the least expensive options is a traditional hard-copy book. In-person instructor-led training augmented with slides and the occasional video is another popular option. Finally, e-learning in either self-study or instructor-led formats offers a third choice. As you consider your delivery options you might wonder whether some media are more effective for learning purposes than others.

Although technology is evolving rapidly, much of what we are seeing today under the e-learning label is not new. Training delivered on a computer, known as computer-based training or CBT, has been around for more than forty years. Early examples delivered over mainframe computers were primarily text on a screen with interspersed questions—electronic versions of behaviorist psychologist B.F. Skinner’s teaching machine. The computer program evaluated answers to the multiple-choice questions and prewritten feedback was matched to the learner responses. One of the main applications of these early e-lessons was to train workers to use mainframe computer systems. As technology has evolved, acquiring greater capability to deliver true

multimedia, the courseware has become more elaborate in terms of realistic graphics, audio, color, animation, and complex simulations. However, as we will see, greater media capabilities do not necessarily ensure more learning.

Each new wave of instructional delivery technology (starting with film in the 1920s) spawned optimistic predictions of massive improvements in learning. For example, in 1947 the U.S. Army conducted one of the first published media comparisons with the hypothesis that film teaches better than classroom instructors (see box for details). Yet after more than sixty years of research attempting to demonstrate that the latest media are better, the outcomes fail to support the superiority of any single delivery medium over another.

THE FIRST MEDIA COMPARISON RESEARCH

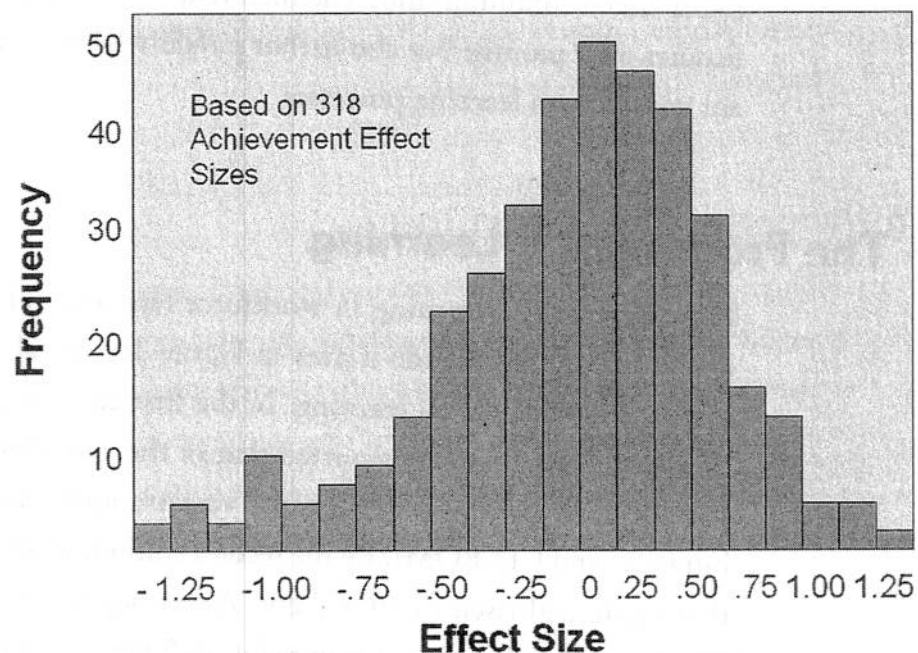
In 1947 the U.S. Army conducted research to demonstrate that instruction delivered by film resulted in better learning outcomes than traditional classroom or paper-based versions. Three versions of a lesson on how to read a micrometer were developed. The film version included a narrated demonstration of how to read the micrometer. A second version was taught in a classroom. The instructor used the same script and included a demonstration using actual equipment along with still slide pictures. A third version was a self-study paper lesson in which the text used the same words as the film, along with pictures with arrows to indicate movement. Learners were randomly assigned to a version and after the training session they were tested to see whether they could read the micrometer. Which group learned more? There were no differences in learning among the three groups (Hall & Cushing, 1947).

With few exceptions, hundreds of media comparison studies have shown no differences in learning (Clark, 1994; Dillon & Gabbard, 1998). A meta-analysis by Bernard et al. (2004) integrating research studies that compared learning from electronic distance education to learning from traditional

classroom instruction yielded the achievement effect sizes shown in Figure 1.3. (See Chapter 3 for information on meta-analysis and effect sizes). As you can see, the majority of effect sizes in the bar chart are close to zero, indicating no practical differences in learning between face-to-face and electronic distance learning. However, the bars at either end of the graph show that some distance learning courses were much more effective than classroom courses and vice versa. A review of online learning by Tallent-Runnels, Thomas, Lan, Cooper, Ahern, Shaw, and Liu (2006) concurs: "Overwhelming evidence has shown that learning in an online environment can be as effective as that in traditional classrooms. Second, students' learning in the online environment is affected by the quality of online instruction. Not surprisingly, students in well-designed and well-implemented online courses learned significantly more, and more effectively, than those in online courses where teaching and learning activities were not carefully planned and where the delivery and accessibility were impeded by technology problems" (p. 116).

Figure 1.3. Electronic Distance Learning Versus Face-to-Face Instruction: Distribution of Effect Sizes.

Adapted from Bernard et al., 2004.



From the plethora of media comparison research conducted over the past sixty years, we have learned that it's not the delivery medium, but rather the instructional methods that cause learning. When the instructional methods remain essentially the same, so does the learning, no matter which medium is used to deliver instruction. Conversely, a course that includes effective instructional methods, will better support learning than a course that fails to use effective methods—no matter what delivery medium is used.

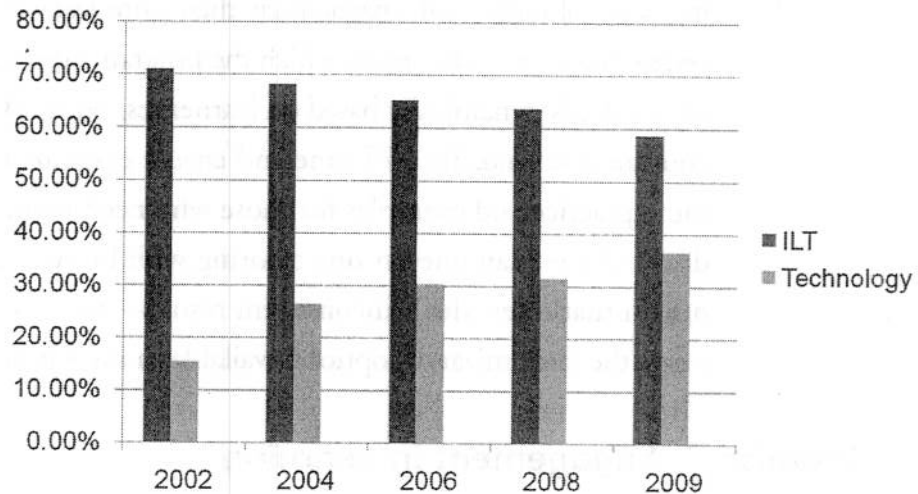
Still, we don't want to leave the impression that all media are equivalent. Each delivery environment has its tradeoffs. Books, for example, are inexpensive, self-paced, and portable but limited to text and still graphics. Classroom instructor-led training offers high social presence and opportunities for hands-on practice, but is instructor-paced and content invariant, requiring all learners to proceed at the same pace and review the same content. Computers represent one of the most flexible media options, as they support media elements of text, graphics (still and animated) and audio. Computers offer opportunities for unique engagement with simulations or with highly immersive environments that in some cases would be impossible to replicate outside a digital environment. In addition, computers offer opportunities to tailor learning—opportunities that are difficult to achieve outside of one-to-one human tutoring. With Web 2.0, computers offer multi-lateral communication channels that span time and space. All of these features offer promise but also harbor pitfalls when not used in ways congruent with human learning processes.

The Promise of e-Learning

How popular is e-learning in workforce learning? The trends in delivery media for the last decade shown in Figure 1.4 reveal a steadily increasing market share for digital learning. In the first edition of *e-Learning and the Science of Instruction*, we reported that in the year 2001, approximately 11 percent of all training was delivered via computer (including the Internet, intranets, and CD-ROM). By the second edition, written at the end of 2006, that figure had risen to 29 percent. As we begin the second decade of the 21st Century, e-learning accounts for 36.5 percent of delivery (ASTD State

Figure 1.4. Percentage of Learning Hours Available Via ILT (Instructor-Led Training) and Technology.

Adapted from ASTD's *State of the Industry Report*, 2010.



of the Industry Report, 2010). Driven by economic conditions that seek more cost-effective forums for training as well as by continued evolution of computer technology, e-learning now accounts for over one-third of all workforce learning delivery.

Organizations are turning to e-learning to save training time and travel costs associated with traditional face-to-face learning. However, cost savings are only an illusion when e-learning does not effectively build knowledge and skills linked to desired job outcomes. Will you leverage the potential of e-learning to provide relevant and cost-effective learning environments? Part of the answer depends on the quality of the instruction embedded in the e-learning products you are designing, building, or selecting today. We propose that the opportunities to foster learning via digital instruction rely on appropriate leveraging of four unique features that we summarize in the following paragraphs.

Promise 1: Customized Training

Self-study asynchronous e-learning has the potential to customize learning to the unique needs of each learner. By unique needs, *we don't mean learning styles*—a myth still popular among training practitioners in spite of a

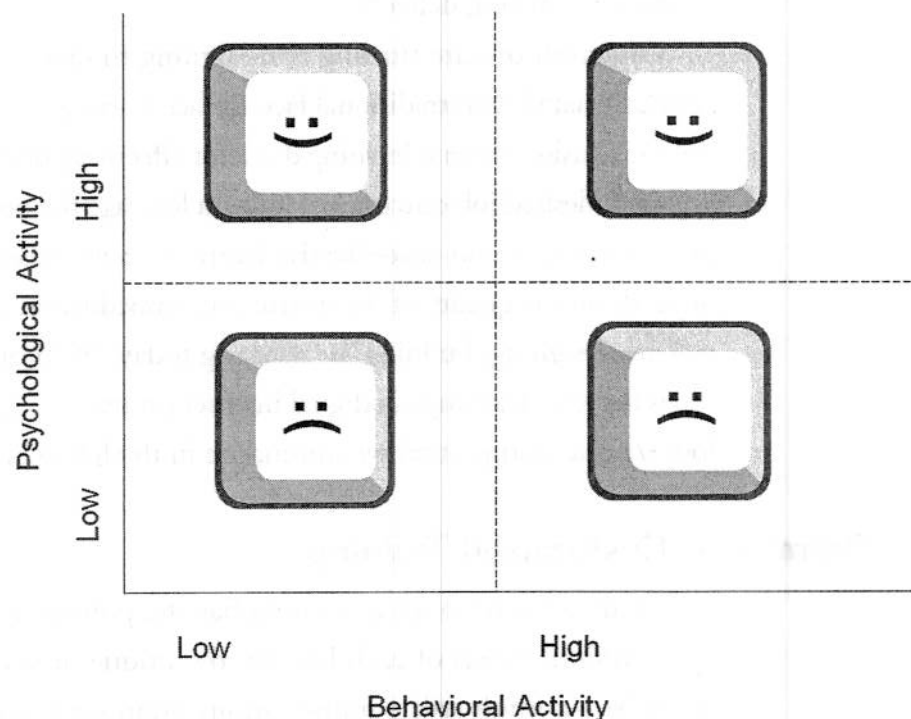
lack of evidence to support it (Clark, 2010; Pashler, Bain, Bottage, Graesser, Koedinger, McDaniel, & Metcalfe, 2007). By customized training we mean tailoring content and instructional methods based on the work roles and learning needs of individuals (particularly their prior knowledge). In Chapter 14 we review adaptive e-learning in which the program customizes content and training methods dynamically based on learner responses. With adaptive e-learning you can save valuable staff time and ensure consistent learning by providing more practice and examples for those who need them and less for those who don't. Other than one-on-one tutoring with human mentors—an expensive option that often yields inconsistent results—no other delivery environment offers the customization options available in asynchronous e-learning.

Promise 2: Engagement in Learning

Regardless of delivery media, all learning requires engagement. In Figure 1.5 we show our Engagement Matrix, which includes two types of activity: behavioral and psychological. By *behavioral engagement* we mean any overt

Figure 1.5. The Engagement Matrix.

Adapted from Stull and Mayer, 2007.



action a learner takes during an instructional episode. Some examples of behavioral activities in e-learning include pressing the forward arrow, typing an answer in a response box, clicking on an option from a multiple-choice menu, verbally responding to an instructor's question, selecting an action from a pull-down menu, or using text chat during a webinar. By *psychological engagement*, we mean cognitive processing of content in ways that lead to acquisition of new knowledge and skills. Some cognitive processes that lead to learning include paying attention to the relevant material, mentally organizing it into a coherent representation, and integrating it with relevant prior knowledge. Some examples of activities in e-learning intended to prime psychological engagement include self-explaining a complex visual, summarizing a portion of a lesson, generating an outline or drawing based on the lesson, or taking a practice test.

As you can see in Figure 1.5, the matrix crosses high and low behavioral activity against high and low psychological activity. Learning occurs in the upper cells of the matrix in the zones of high psychological activity. Note that high levels of behavioral activity do not necessarily correspond with high levels of psychological activity (lower right quadrant). Pressing the forward button in e-learning or playing a computer game such as PacMan involve high levels of behavioral activity but little psychological activity that leads to learning. In contrast, carefully watching an animation explained with audio narration involves little or no behavioral activity but will lead to psychological activity needed for learning. Our point is that high levels of behavioral activity don't necessarily translate into the type of psychological processing that supports learning. Likewise, meaningful learning can occur in the absence of behavioral responses. Your goal is to use media elements and instructional methods that fall into the upper half of the matrix. Throughout this book we will show evidence-based techniques to help you achieve that goal.

Promise 3: Multimedia

In e-Learning, you can use a combination of text and audio, as well as still and motion visuals to communicate your content. Fortunately, we have a healthy arsenal of research to guide your best use of these media elements that we discuss in Chapters 4 through 10.

Promise 4: Acceleration of Expertise Through Scenarios

Studies of experts across a wide variety of domains show that about ten years of experience are needed to reach high levels of proficiency (Ericcson, 2006). In some work settings, getting that experience can take years because situations that require certain skills rarely present themselves. e-Learning, however, offers opportunities to immerse learners in job-realistic environments requiring them to solve infrequent problems or complete tasks in a matter of minutes that could take hours or days to complete in the real world. For example, when troubleshooting equipment, some failures are infrequent and may require considerable time to resolve. A computer simulation, however, can emulate those failures and give learners opportunities to resolve them in a realistic work environment such as the one in Figure 1.6. In Chapter 15 we discuss e-learning programs such as this one designed to build thinking skills.

Figure 1.6. A Simulated Automotive Shop Offers Accelerated Learning Opportunities.

With permission from Raytheon Professional Services.



The Pitfalls of e-Learning

The powerful features of e-learning are a two-edged sword with many potential traps that sabotage learning. Here we summarize some of the major pitfalls that can rob your organization of a return on investment in digital learning:

Pitfall 1: Too Much of a Good Thing

As we will see in Chapter 2, the human cognitive system is limited, and when it comes to instruction, less is almost always more. It's tempting to use an eye-catching mix of animations, sounds, audio, and text to convey your content. However, we have good evidence to support our advice: Don't do it. Read Chapter 8 on the Coherence Principle to learn the details.

Pitfall 2: Not Enough of a Good Thing

At the other end of the spectrum you can find e-learning that, in fact, is minimalist in that it fails to make use of features proven to promote learning. For example, a wall-of-words approach ignores opportunities to leverage relevant visuals by providing explanations that use text and more text. Alternatively, some e-learning, called "page turners," omits interactivity other than the forward and back buttons. These courses may present screen after screen of stunning animations but don't provide the learners with overt opportunities to process the content through practice exercises or simulations.

Pitfall 3: Losing Sight of the Goal

In 2009, \$126 billion were invested in workforce learning in the United States alone (ASTD State of the Industry Report, 2010). We suspect there is little evidence of return on that investment—a safe speculation on our part because most organizations don't invest the time or resources to assess outcomes from their training. Regardless of delivery medium, any training development process must identify key skills that promote organizational goals and build training around the tasks that constitute those skills. Be it games, virtual worlds, or social media, technophiles gravitate toward the latest cool trends—sometimes without considering whether and how best to leverage them in ways that support relevant learning.

Pitfall 4: Discovery Learning

Because the metaphor of the Internet is high learner control, allowing users to search, locate, and peruse thousands of Internet sites, a tempting pitfall is to create highly exploratory learning environments that give learners an unrestricted license to navigate and piece together their own unique learning experiences. One lesson we have learned from over fifty years of research on discovery learning is that it rarely works (Mayer, 2004). Instead, as we discuss in Chapter 16, we recommend a structured form of e-learning lesson that provides guidance.

Inform and Perform e-Learning Goals

As summarized in Table 1.1, the guidelines in this book apply to e-learning that is designed to inform as well as e-learning that is designed to improve specific job performance. We classify lessons that are designed primarily to build awareness or provide information as *inform programs*, also known as briefings. A new employee orientation module that reviews the company history and describes the company's organization or a product knowledge update are examples of topics that are often presented as inform programs. The information presented is job relevant, but there may be no specific expectations of new skills to be acquired. The primary goal of these programs is to transmit information.

Table 1.1. Inform and Perform e-Learning Goals.

<i>Goal</i>	<i>Definition</i>	<i>Example</i>
Inform	Lessons that communicate information	<ul style="list-style-type: none">• Company history• New product features
Perform Procedure	Lessons that build procedural skills (to promote near transfer)	<ul style="list-style-type: none">• How to log on• How to complete an expense report
Perform Tasks	Lessons that build strategic skills (to promote far transfer)	<ul style="list-style-type: none">• How to close a sale• How to analyze a loan

In contrast, we classify programs designed to build specific skills as *perform programs*. Some typical examples of perform e-learning are lessons on software use, designing a database, or troubleshooting an automotive failure. Many e-courses contain both inform and perform learning objectives, while some are designed for inform only or perform only.

Near Versus Far Transfer Perform Goals

We distinguish between two types of perform goals: (1) procedural, which promote *near transfer*, and (2) strategic, which promote *far transfer*. Procedural lessons such as the Excel examples in Figures 1.1 and 1.2 are designed to teach step-by-step tasks, which are performed more or less the same way each time. Many end-user computer-skills courses fall into this category. This type of training promotes near transfer because the steps learned in the training are identical or very similar to the steps required in the job environment. Thus, the transfer from training to application is near.

Lessons designed to build strategic skills teach general approaches to tasks that do not have one correct approach or outcome. Thus, the situations presented in the training may not be exactly the same as the situations that occur on the job. These tasks require the worker to adapt guidelines to various job situations. Typically, some element of problem solving is involved. The worker always has to use judgment in performing these tasks because there is no one right approach for all situations. Far transfer lessons include just about all soft-skill training, supervision and management courses, and sales skills. Figure 1.6 illustrates a screen from a far transfer course on troubleshooting. The lesson begins with a work order specifying a high idle problem in the automobile. The learner has access to the testing equipment you see in the shop to take and record measurements. The shop computer links the learner to actual online reference resources and the telephone offers testing hints. When the learners are ready to interpret the data collected, they select the appropriate failure and repair action from a list. As feedback, a list of testing activities and times from an expert repair is displayed next to a list of the learner's activities and times, which were tracked during the learner's progress through the lesson.

e-Learning Architectures

Although all e-learning is delivered on a digital device, different courses reflect different assumptions of learning, which we introduce here and describe in detail in Chapter 2. During the past one hundred years, three views of learning have evolved, and you will see each view reflected in courses available today. The three architectures and the learning assumptions on which they are based, summarized in Table 1.2, are *receptive* based on an *information acquisition* view, *directive* based on a *response strengthening* view, and *guided discovery* based on a *knowledge construction* view. We describe these three views in greater detail in Chapter 2.

Table 1.2. Three e-Learning Architectures.

Architecture	View	Inter-Activity	Used For
Receptive	Information Acquisition	Low	Inform training goals such as new hire orientation
Directive	Response Strengthening	Medium	Perform procedure training goals such as software skills
Guided Discovery	Knowledge Construction	High	Perform strategic training goals such as problem solving

Interactivity in the Architectures

The interactivity of the lessons (from low to high) is one important feature that distinguishes lessons built using the various architectures. Receptive types of e-learning fall at the lower end of the behavioral interactivity continuum as they incorporate little or no opportunities for overt learner responses. Receptive lessons are used most frequently for inform training goals. For learning to occur, the lesson must include techniques that prompt high psychological engagement in the absence of behavioral activity. In other words, effective receptive lessons would fall into the upper left quadrant of the engagement matrix shown in Figure 1.5.

Directive lessons follow a sequence of “explanation-example-question-feedback.” These architectures, commonly designed for perform procedure training goals, incorporate highly structured practice opportunities designed to guide learning in a step by step manner. The Excel lessons shown in Figures 1.1 and 1.2 reflect a directive architecture. The high degree of structure and guidance in directive architectures makes them suitable for learners who are new to the content and skills.

Effective guided discovery forms of e-learning, including simulations and games, engage learners both behaviorally and psychologically. For example, Figure 1.6 shows the interface for a guided discovery course in which the learner is problem solving by selecting and interpreting troubleshooting tests leading to accurate diagnosis of an automotive failure. We describe guided discovery architectures in Chapters 15 and 16. Because these types of lessons require learners to solve a problem and learn from its solution, they impose more mental load than the directive architectures. Therefore, they are generally more appropriate for more experienced learners and for building far transfer skills.

Learning is possible from any of these three architectures if learners engage in active knowledge construction. In receptive courses, you will want to use media elements and instructional methods that stimulate psychological activity in the absence of behavioral activity. We will review many proven methods of this type in Chapters 4 through 11. In directive and guided discovery architectures, knowledge construction is overtly promoted by the interactions built into the lessons. In the next chapter we dig a little deeper into the psychological processes needed for learning and how instructional methods can support or defeat those processes.

What Is Effective e-Courseware?

A central question for our book is: “What does effective courseware look like?” Throughout the book we recommend specific features to look for or to design into your e-learning. However, you will need to adapt our recommendations based on three main considerations—the goal of your training, the prior knowledge of your learners, and the environment in which you will develop and deploy your training.

Training Goals

The goals or intended outcomes of your e-learning will influence which guidelines are most appropriate for you to consider. Earlier in this chapter we made distinctions among three types of training designed to inform the student, to perform procedures, and to perform strategic tasks. For inform e-lessons, you should apply the guidelines in Chapters 4 through 11 regarding the best use of media elements, including visuals, narration, and text to present information as well as how to use examples effectively. To help learners acquire procedural skills, you should apply these guidelines and add to them relevant evidence for best design of practice sessions in Chapter 12. If, however, your goal is to develop strategic or far transfer skills, you will want to apply the guidelines from all the chapters, including Chapter 15 on teaching problem-solving skills and Chapter 16 on games and simulations.

Learner Differences

In addition to selecting or designing courseware specific to the type of outcome desired, lessons should include instructional methods appropriate to the learner's characteristics. While various individual differences such as learning styles have received the attention of the training community, research has shown that the learner's prior knowledge of the course content exerts the most influence on learning. Learners with little prior knowledge will benefit from different instructional strategies than will learners who are relatively experienced.

For the most part, the guidelines we provide in this book are based on research conducted with adult learners who were new to the course content. If your target audience has greater background knowledge in the course content, some of these guidelines may be less applicable. For example, Chapter 6 suggests that if you explain graphics with audio narration rather than text, you reduce the mental workload required of the learner and thereby increase learning. However, if your learners are experienced regarding the skills you are teaching, overload is not as likely and they will probably learn effectively from either text or audio explanations of visuals.

Environment

A third factor that affects e-learning is the environment—including such issues as technical constraints of the delivery platform, network, and software, cultural factors in institutions such as the acceptance of and routine familiarity with technology, and pragmatic constraints related to budget, time, and management expectations. In this book we focus on what works best from a psychological perspective, but we recognize that you will have to adapt our guidelines to your own unique set of environmental factors.

Learning in e-Learning

The challenge in e-learning, as in any learning program, is to build lessons in ways that are compatible with human learning processes. To be effective, instructional strategies must support these processes. That is, they must foster the psychological events necessary for learning. While the computer technology for delivery of e-learning is upgraded weekly, the human side of the equation—the neurological infrastructure underlying the learning process—is very old and designed for change only over evolutionary time spans. In fact, technology can easily deliver more sensory data than the human nervous system can process. To the extent that audio and visual elements in a lesson interfere with human cognition, learning will be depressed.

We know a lot about how learning occurs. Over the past twenty years, hundreds of research studies on cognitive learning processes and methods that support them have been published. Much of this new knowledge remains inaccessible to those who are producing or evaluating online learning because it has been distributed primarily within the research community. This book fills the gap by summarizing research-based answers to questions that multimedia producers and consumers ask about what to look for in effective e-learning.

COMING NEXT

Since instructional methods must support the psychological processes of learning, the next chapter summarizes those processes. We include an overview of our current understanding of the human learning system and the

processes involved in building knowledge and skills in learners. We provide examples of how instructional methods used in e-lessons support cognitive processes.

Suggested Readings

Clark, R.C. (2010). *Evidence-based training methods*. Alexandria, VA: ASTD Press.

Clark, R.C., & Mayer, R.E. (2008). Learning by viewing versus learning by doing: Evidence-based guidelines for principled learning environments. *Performance Improvement*, 47, 5–13.

Clark, R.E. (1994). Media will never influence learning. *Educational Technology Research and Development*, 42, 21–30.

Mayer, R.E. (2004). Should there be a three-strikes rule against pure discovery learning: The case for guided methods of instruction. *American Psychologist*, 59(1), 14–19.