CHAPTER OUTLINE

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WHAT’S NEW IN THIS CHAPTER?

LEARNER CONTROL is implemented by navigational features such as menus, site maps, and links that allow learners to select the topics and instructional elements they prefer. In the second edition of *e-Learning and the Science of Instruction*, we recommended that you adjust the amount of learner control in asynchronous e-learning based primarily on the prior knowledge of your learners. Learners with higher prior knowledge can typically make good choices under conditions of high learner control. However, most novice learners often don’t know enough about the content domain to benefit from learner control. Research data continue to support this recommendation. In our update we summarize new research on adaptive control in which instructional elements are dynamically personalized based on learner performance during the lesson.
Based on the segmentation principle summarized in Chapter 10, we recommend that in asynchronous e-learning, you always allow learners to control pacing so they can proceed at their own rate.

**DESIGN DILEMMA: YOU DECIDE**

The e-learning design team is discussing the navigation controls for the spreadsheet course currently under development:

Ben: "Here’s my first cut at the navigation controls. (See Figure 14.1.) We’ll set up the left navigation so they can jump to any topic they want and can skip lesson topics they don’t find relevant. And to see some examples, the learner can click on the baby screens. Also I’m adding a lot of links so the learners can jump to the practice exercises or skip them if they feel that they understand the concepts. Links are also good for definitions and as a route to other relevant websites. That’s what people expect on the Internet. The Millennial generation has grown up with complete control in all their digital environments."

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**Figure 14.1. Navigational Elements Designed for High Learner Control.**

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

When copying a formula, you may want one or more elements of the cell (column or row) to remain the same. This is called absolute cell references. Click on baby screens above to see examples of absolute cell references. Click here for a practice. Otherwise, select another topic.
Control over the content and pace of a lesson is a common feature of asynchronous e-learning. Certainly the underlying scheme of the Internet is freedom of choice. How effective is learner control in training? What are the tradeoffs between learner control and program control? Fortunately, we have evidence from research and from cognitive theory to guide our decisions.

**Learner Control Versus Program Control**

In contrast to classroom and synchronous e-learning, asynchronous e-learning can be designed to allow learners to select the topics they want, control the pace at which they progress, and decide whether to bypass some lesson elements such as examples or practice exercises. e-Learning programs that offer these choices are considered high in learner control. In contrast, when the course and lesson offer few learner options, the instruction is under program control. Most synchronous forms of e-learning operate in program...
control mode—also called *instructional control*. Instructor-led virtual and face-to-face classrooms typically progress at a single pace, follow a linear sequence, and use one set of teaching techniques. The instructor facilitates a single learning path. On the other hand, asynchronous e-learning can offer many or few options and thus can be designed to be learner controlled or program controlled.

### Three Types of Learner Control

Although the term “learner control” is often used generically, the actual type of control varies. Thus, two courses that are depicted as “learner-controlled” may in fact offer quite different options. In general, control options fall into three domains:

1. **Content Sequencing.** Learners can control the order of the lessons, topics, and screens within a lesson. Many e-courses such as the design in Figure 14.1 allow content control through a course menu from which learners select topics in any sequence they wish. Likewise, links placed in lessons can lead to additional pages in the course or to alternative websites with related information.

2. **Pacing.** Learners can control the time spent on each lesson page. With the exception of short video or audio sequences, a standard adopted in virtually all asynchronous e-learning allows learners to progress through the training at their own rate, spending as much or as little time as they wish on any given screen. Likewise, options to move backward or to exit are made available on every screen. A more extensive form of pacing control allows learners to use slider bars or rollers to move through the content or includes fast forward, rewind, pause, and play buttons.

3. **Access to Learning Support.** Learners can control instructional components of lessons such as examples or practice exercises. Within a given lesson, navigation buttons, links, or tabs lead to course objectives, definitions, additional references, coaches, examples, help systems, or practice exercises. In contrast, a program-controlled lesson
provides most of these instructional components by default as the learners click the forward button.

Figure 14.2 shows a screen from an asynchronous course that allows control over all three of these domains. At the bottom right of the screen the directional arrows provide for movement forward or backward at the learner’s own pace. The course uses Microsoft standard control buttons in the upper right-hand corner of the screen as well as an on-screen button to exit. In the left-hand frame, the course map allows learners to select lessons in any sequence. Within the central lesson frame, the learner can decide to study the examples by clicking on the thumbnail sample screens to enlarge them. Learners can also select a practice exercise by either clicking on the link above the examples or on the navigational tab on the right-hand side. In addition, embedded links lead to definitions of terms. Table 14.1 summarizes the most common techniques used to implement various forms of learner control in asynchronous e-learning.

Figure 14.2. A Lesson with Multiple Navigational Control Elements.
With permission from Element K.

<table>
<thead>
<tr>
<th>Technique</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course and lesson menus in left-hand frame, pull-down window, or section tabs</td>
<td>Allow learners to select specific lessons and topics within a lesson or a course</td>
<td>Figures 14.1 and 14.2 both use left window menu lists</td>
</tr>
<tr>
<td>Links placed within teaching frame</td>
<td>Allow learners to access content from other sites on the Internet or from other sections within the course</td>
<td>Figures 14.1 and 14.2 include links leading to definitions or practice exercises</td>
</tr>
<tr>
<td>Pop-ups or mouse-overs</td>
<td>Provide additional information without the learning having to leave the screen</td>
<td>Figure 5.2 includes roll-over functionality. When the learner clicks on a screen icon, a small window explains its functions</td>
</tr>
<tr>
<td>Buttons to activate forward, backward, pause, replay, and quit options</td>
<td>Permit control of pacing among pages within a lesson and of media elements such as video incorporated into a lesson page</td>
<td>The lesson shown in Figure 14.2 includes buttons for movement forward, backward, and exit</td>
</tr>
<tr>
<td>Guided tours</td>
<td>Overviews of course resources accessible from the main menu screen</td>
<td>Typically used in courses that offer very high learner control such as game-type interfaces with multiple paths and interface options</td>
</tr>
<tr>
<td>Active objects</td>
<td>Graphics on the screen serve as links leading to information or locations relevant to the object</td>
<td>Figure 1.6. shows an automotive shop graphic interface. All major objects are linked to either troubleshooting tests or reference guides</td>
</tr>
</tbody>
</table>
Learners like learner control! To the extent that student appeal is a major goal of your instructional projects, learner control is a definite satisfier. Given the high levels of control inherent on the Internet, it is likely that learners will expect the same kind of freedom in e-learning courses.

Rather than advocate for or against learner control, we provide guidelines and illustrations for when and how learner control is best used. Additionally, we describe the option of adaptive control that tailors learning environments based on an automated assessment of learner progress and needs.

Do Learners Make Good Instructional Decisions?

How accurately do you think most learners determine what they already know and what they need to learn? If learners can accurately assess themselves, they can make good decisions about topics to study and how much time and effort to put into studying those topics. In short, they are capable of good achievement when given learner control. We have two lines of evidence indicating that, in fact, most learners are not good at self-assessment: calibration accuracy and student lesson ratings.

Calibration Accuracy: Do You Know What You Think You Know?

Suppose you have to take a test on basic statistics. Prior to taking the test, you are asked to estimate your level of confidence in your knowledge. You know that even though you took statistics in college, you are a little rusty on some of the formulas, but you figure that you can score around 70 percent. After taking the test, you find your actual score is 55 percent. The correlation between your confidence estimate and your actual performance is called calibration. Had you guessed 55 percent, your calibration would have been perfect.

The focus of calibration measurement is not on what we actually know, but on the accuracy of what we think we know. If you don’t think you know much and in fact your test score is low, you have good calibration. Test your own calibration now by answering this question: What is the capital of Australia? As you state your answer, also estimate your confidence in your answer as high, medium, or low. You can check your calibration on the following page.
Although most of us may feel we have a general sense of what we do and do not know, our specific calibration accuracy tends to be poor (Stone, 2000). Glenberg, Sanocki, Epstein, and Morris (1987) found calibration correlations close to zero, concluding that “contrary to intuition, poor calibration of comprehension is the rule, rather than the exception” (p. 119). Eva, Cunnington, Reiter, Keane, and Norman (2004) report poor correlations between medical students’ estimates of their knowledge and their actual test scores. When comparing knowledge estimates among Year 1, Year 2, and Year 3 medical students, there was no evidence that self-assessments improved with increasing seniority. The team concludes that “Self-assessment of performance remains a poor predictor of actual performance” (p. 222).

Even experienced physicians have been shown to lack accurate self-assessment of their own performance. Violato and Lockyer (2006) compared self-assessments of physicians in several specialty areas with assessment data from their peers. Similar to 360-degree feedback management programs used in many companies, The Physician Achievement Review program provides doctors with feedback from patients, colleagues, and non-physician co-workers such as nurses. The physician also completes a self-assessment form on a five-point scale with questions such as “Compared to other physicians I know, I rate my communication skills as 1, 2, 3, 4, or 5” with 1 equal to among the worst and 5 equating to among the best. The research team compared 305 medical specialists’ self-assessments with medical colleague assessments. They found that physicians with poor peer ratings rated their own performance as above average—approximately 30 to 40 percentage points higher than their peers rated them. Conversely, high-performing physicians tended to underestimate their performance. The research team concludes that “Overall results provide strong evidence to support the notion that many physicians are not very good at accurate self-assessment” (p. 239).

Now let’s check on your calibration. Review your response to our question on the previous page about the capital of Australia. The capital of Australia is not Sydney, as many people guess with high confidence. It is Canberra. If you guessed Sydney with low confidence or if you guessed Canberra with high confidence, your calibration is high!
In comparing calibration of individuals before and after taking a test, accuracy is generally better after responding to test questions than before. Therefore, providing questions in training should lead to more accurate self-assessments. Walczyk and Hall (1989) confirmed this relationship by comparing the calibration of learners who studied using four resources: text alone, text plus examples, text plus questions, and text plus examples and questions. Calibration was best among those who studied from the version with examples and questions.

Do Learners Like Instructional Methods That Lead to Learning?

Most courses ask learners to evaluate the quality of the course with an end-of-course rating sheet. Do you think there is a high relationship between these end-of-course learner ratings and actual learning? Sitzmann, Brown, Casper, Ely, and Zimmerman (2008) correlated approximately eleven thousand student course ratings with after-training knowledge measures as well as 4,688 course ratings with after-training procedural skills. The correlations were very small: .12 and .15, respectively. Remember that correlations range from –1 to +1 with values around zero indicating no correspondence whatsoever between the values. The research team concludes: “Reactions have a predictive relationship with cognitive learning outcomes, but the relationship is not strong enough to suggest reactions should be used as an indicator of learning” (p. 289).

Do students learn more when matched to their preferred instructional methods? Schnackenberg, Sullivan, Leader, and Jones (1998) surveyed participants before taking a course regarding their preferences for amount of practice—high or low. Participants were assigned to two e-learning courses—one with many practice exercises and a second identical course with half the amount of practice. Half the learners were matched to their preference and half mismatched. Regardless of their preference, those assigned to the version with more practice achieved significantly higher scores on the post-test than those taking the version with fewer practice exercises.

The bottom line: there is little correspondence between learner perceptions of lesson effectiveness and actual instructional value. In short, liking is not the same as learning.
Psychological Reasons for Poor Learner Choices

We’ve seen that calibration research as well as correlations between student ratings and student learning point to a general inability to accurately assess learning needs. Metacognition refers to a learners’ awareness and control of their own learning processes, such as assessing how well they understand a lesson or knowing how best to study to achieve a learning goal. Metacognition is the mind’s operating system. In short, metacognition supports mental self-awareness and self-regulation. Individuals with high metacognitive skills set realistic learning goals and use effective study strategies. They have high levels of learning management skills. For example, when faced with a certification test, they plan a study schedule. Based on accurate self-assessments of their current strengths and weaknesses, they focus their time and efforts on the topics most needed for success. They use appropriate study techniques based on an accurate assessment of the certification requirements. In contrast, learners with poor metacognitive skills lack understanding of what they know and how they learn, which will lead to flawed decisions under high learner control.

Moos and Azevedo (2008) compared metacognitive activities among high and low prior knowledge learners as they researched a hypermedia resource on the circulatory system. After a pre-test to evaluate knowledge levels, college students were allowed forty minutes to study the circulatory system from an online encyclopedia that included articles, video, figures, and other information. Students were asked to talk aloud while they studied, and their self-regulatory patterns were compared. The research team found that learners with high prior knowledge used more planning and monitoring processes as they reviewed the materials. In contrast, lower prior knowledge learners did little planning or monitoring but instead took notes. Because planning and monitoring require working memory capacity, it is likely that low prior knowledge learners did not have sufficient mental resource for self-regulatory activities. The research team recommends adding guidance to hypermedia environments that will be accessed by novice learners. For example, adding frequent questions with detailed feedback may alleviate the learners’ need to devote working memory resources to monitor their own progress.
Chapter 14: Who’s in Control?

How can you best apply the evidence and the psychology behind learner control to your design of effective e-courses? In the rest of this chapter, we discuss the following five proven guidelines for the best use of learner control to optimize learning:

Principle 1: Give experienced learners control.
Principle 2: Make important instructional events the default.
Principle 3: Design adaptive control.
Principle 4: Give pacing control.
Principle 5: Offer navigational support in hypermedia environments.

Learner Control Principle 1: Give Experienced Learners Control

As we have seen, most learners prefer full control over their instructional options but often don’t make good judgments about their instructional needs—especially those who are novice to the content and/or who lack good metacognitive skills. Hence the instructional professional must consider the multiple tradeoffs of learner control, including learner satisfaction, the profile of the target learners, the cost of designing learner-controlled instruction, and the criticality of skills being taught.

A review of research on learner versus program control concludes that learners with little prior knowledge of the subject as well as poor metacognitive skills are likely to do better with program control—especially in high-complexity courses (Steinberg, 1989). Learner control is more likely to be successful when:

- Learners have prior knowledge of the content and skills involved in the training
- The subject is a more advanced lesson in a course or a more advanced course in a curriculum
- Learners have good metacognitive skills
- The course is of low complexity
Evidence for Benefits of Program Control

Gay (1986) found that low prior knowledge students learned more under program control than under learner control. Figure 14.3 shows learning outcomes from high and low prior knowledge students under learner and program control. In this experiment, individuals in the learner control version could control topic sequencing, presentation mode (video, audio, graphics, or text), number of examples, amount of practice, and depth of study. Those in program control could control only pacing. As you can see, while low prior knowledge learners had low scores under learner control, high prior knowledge learners did well under either condition. Gay (1986) concludes: “The results demonstrate that not all subjects were capable of making appropriate decisions. The low knowledge students practiced too little and emphasized areas with which they already had familiarity. In summary, low prior knowledge subjects did not use good learning strategies and made poor sequencing decisions under learner controlled treatment” (p. 227).

Figure 14.3. Low Prior Knowledge Students Learn Least Under Learner Control.

Young (1996) compared outcomes of learners with high and low self-regulatory (metacognitive) skills who took four e-lessons in either a
learner-control or program-control mode. Under learner control, participants could select or bypass definitions, examples, and practice exercises, whereas those in the program-controlled version were presented with all the above options. Those in the learner-controlled version looked at less than 50 percent of the total number of screens available. As summarized in Table 14.2, Young found that learners with low metacognitive skills learned less in the learner-controlled mode than any of the other three groups did.

<table>
<thead>
<tr>
<th>Table 14.2. Test Scores of High and Low Metacognitive Learners Studying Under Learner or Program Control.</th>
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<tbody>
<tr>
<td>From Young, 1996.</td>
</tr>
<tr>
<td>Learner-Controlled</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Low Metacognitive Skill</td>
</tr>
<tr>
<td>High Metacognitive Skill</td>
</tr>
</tbody>
</table>

Overall, there is a consistent pattern in which too much learner control can be detrimental to learners with either low prior knowledge or metacognitive skill. In contrast, high prior knowledge learners are more likely to have sufficient domain knowledge to make appropriate instructional choices.

Evidence for Learner Control Later in Learning
Lee and Lee (1991) compared learning from program control and learner control over the sequence of tasks and number of practice exercises completed in a computer-based chemistry lesson. Learning was compared during early stages of learning versus later stages of learning, when learners would have acquired a knowledge base. Program control gave better results during initial learning, whereas learner control was more effective at later stages. This outcome supports the idea that learners with greater prior knowledge are able to make more appropriate decisions under conditions of learner control. Based on evidence to date, we recommend that when selecting or
designing courseware for novice learners, look for greater program control—at least in the beginning lessons in a course.

**Learner Control Principle 2: Make Important Instructional Events the Default**

We saw in Chapter 12 that practice is an important instructional method that leads to expertise. We also know that learners prefer learner control, and in many e-learning environments, they can easily drop out if not satisfied. Therefore, if you opt for high learner control, set the default navigation option (usually the continue button) to lead to important instructional elements such as practice exercises. In other words, require the learner to make a deliberate choice to bypass practice.

Research by Schnackenberg and Sullivan (2000) supports this guideline. Two navigational versions of the same lesson were designed. As illustrated in Figure 14.4, in one version, pressing “continue” bypassed practice while in the other version pressing “continue” led to practice. In the “more practice” default (Version 2), participants viewed nearly twice as many of the screens as those in Version 1 and scored higher on the final test.

**Figure 14.4. Default Navigation Options That Bypass Practice (Version 1) Led to Poorer Learning Than Default Options That Lead to Practice (Version 2).**

Programs that make a high amount of practice available as the default route are more likely to result in higher achievement than those that make
less practice available as the default route. Schnackenberg and Sullivan (2000) suggest that program control should be a preferred mode because learner-controlled programs (1) have no instructional advantages, (2) have been shown in other studies to be disadvantageous for low-ability learners, and (3) cost more than program control.

However, their learner population consisted of students taking a required university course. In your environment, where learners have greater freedom about whether to take or complete e-learning, you may not be able to downplay user preferences to the extent recommended in this study. When designing programs with high learner control, set the continue or next button so that critical aspects of the program (such as examples or practice exercises) are the default options.

**Learner Control Principle 3: Consider Adaptive Control**

One of the unique features of asynchronous e-learning is the opportunity to dynamically tailor instruction to the changing needs of learners as they are learning. In adaptive control (also called personalized instruction or user modeling), the program dynamically adjusts lesson difficulty and support based on the program’s evaluation of learner responses. As a simple example, if a learner completes six exercise questions and has them all correct, she is branched to a more difficult lesson topic. In contrast, if she has three of six correct, additional worked examples are provided followed by more practice exercises. In other words, the instruction monitors learning and adjusts the difficulty level and the amount of guidance accordingly.

As we have seen in prior chapters, many instructional methods that benefit novice learners often have no effect or even sometimes depress the learning of individuals with more background knowledge. For example, in Chapter 11 we saw evidence that worked examples that were helpful for novice learners gradually lose their effectiveness as learners gain expertise. In fact, eventually higher prior knowledge learners will do better with problem assignments than with worked examples. The different effects of instructional methods on novices compared to higher prior knowledge learners is called expertise
As a generality, expertise reversal recommends increasing the difficulty of the instructional assignments and decreasing the amount of instructional support as learning progresses. We know that learning occurs at different rates for different individuals. Therefore, one design challenge is determining at what point in the lesson to make a transition in difficulty or guidance for an individual learner. A solution to this challenge is dynamic adaptive control.

**Evidence for Dynamic Adaptive Control vs. Program Control**

Salden, Paas, Broers, and Van Merrienboer (2004) confirmed the advantages of dynamic adaptive e-learning. They compared the effectiveness of program control with dynamic adaptive control on learning of simulated air traffic control scenarios. Program control assigned each learner twenty practice tasks from simple to more complex. Dynamic adaptive control adjusted the number and complexity of practice tasks based on the learner’s performance on practice tasks. There were no differences in learning between program and adaptive groups. However, the program-controlled version required the greatest time to complete. In the program-controlled version, all learners received twenty tasks, whereas learners in adaptive lessons completed an average of ten tasks.

Corbalan, Kester, and van Merrienboer (2008) compared learning, time spent in training, and student ratings of mental load between lessons that used adaptive control and lessons that were not adapted. Fifty-five vocational education students completed a course that involved a series of dietetics problems. For each skill area five problems were constructed ranging from simple to complex. In addition, for each problem five levels of support were constructed, ranging from full worked examples to full problem assignments. After learners completed a problem, they took a short multiple-choice test to measure competence and they rated the amount of effort they invested. Using an algorithm that included the competence score and student effort ratings, the program then selected a follow-up task. For example, the follow-up task may be of a greater difficulty level with more support or may be of the same difficulty level with less support. Participants in the non-adaptive version received the same sequence of problems regardless of how they scored on the test.
The adaptive condition led to better learning, with mean competence scores of 73, compared to 48 in the non-adaptive condition. Participants in the adaptive condition rated their lessons lower in mental load and spent more time in training than those in the non-adaptive condition.

Determining the competency of a learner as a lesson progresses requires a dynamic method of assessment. However, frequent testing is cumbersome and time-consuming. In the next sections we discuss two recent research reports that evaluated rapid diagnostic methods used to dynamically assess learner competency: rapid verification and accuracy of self-explanations.

**Rapid Verification Method for Dynamic Adaptive Control**

Kalyuga (2008) has validated a fast and practical method for dynamic assessment of learning. He designed tests for algebra tasks. He selected thirty-three university students with a range of mathematical background. Each participant completed a rapid computer-based diagnostic test as well as a traditional paper-based test. His goal was to determine how closely the results from the rapid test corresponded with those from the traditional test.

The rapid diagnostic test shows a problem to be solved followed by five suggested solution steps (one correct and four incorrect). For each solution step shown, the learner indicates whether it is right or wrong. Following the rapid diagnostic test, each individual completed a traditional paper-based test using problems similar to those used in the rapid test. Time to complete each test version was recorded and the scores on the rapid and traditional test were correlated to determine the extent to which the rapid test would give as accurate a diagnosis as a traditional test.

The correlations between the traditional and rapid tests were .71 and .75, suggesting the rapid tests gave a good estimate of student knowledge. Not surprising, test time for the rapid method was reduced by a factor of over three. Kalyuga concludes that the rapid verification procedure is a valid diagnostic method capable of identifying different levels of competency and is fast enough for real-time application.

In Figure 14.5, you can see an example of a rapid verification test item from the algebra lesson. To implement this method, first establish a sequence
of main intermediate stages in a solution procedure for a problem. Next for each stage construct one correct and two or three incorrect solution steps. Then present the original problem to the learner for a limited time, followed by a series of the selected intermediate solution steps one at a time, asking the learner to quickly verify whether the step is correct or incorrect. Use the score from the rapid assessment procedure as the basis for adjusting the problem difficulty and/or amount of guidance provided in the lesson.

**Accuracy of Self-Explanations for Dynamic Adaptive Control**

In this section we review a procedure that assesses competency based on correct selection of self-explanation principles associated with worked examples. Recall from Chapter 11 that a proven method to ensure deep processing of worked examples is to attach a self-explanation multiple-choice question next to a worked step. You can review examples in Figures 11.5 and 11.6. Salden, Aleven, Schwonke, and Renkl (2010) used the accuracy of self-explanations to determine when learners should transition from examples to practice. An advantage of this approach is its unobtrusiveness and efficiency, as the learner does not need to complete additional test items.

To evaluate the effectiveness, the research team compared geometry learning of ninth and tenth graders from three versions of an online geometry
tutorial. The first version used the standard tutor. The second version added worked examples that faded steps out in a fixed manner. The third—adaptive version—added worked examples that were faded based on accuracy of learner selection of self-explanation options. The fading decisions were based on the programs assessment of each individual student’s ability to identify valid explanations of worked-out steps. They found the adaptive fading condition led to better immediate and delayed post-test scores.

**When to Consider Adaptive e-Learning**

As you can see, creating e-learning that dynamically adjusts instruction based on the learner’s demonstrated competence during learning does show promise for better and more efficient learning. At the same time, any form of adaptive learning will require additional development by the instructional team. Extra time and resources will have to be devoted to designing the assessment devices, programming decision logic, and preparing alternative paths of instruction for different learners. Will this investment pay off?

We suggest that you consider adaptation when you have a large group of heterogeneous learners for which you would anticipate quite different levels of instructional support needed to achieve the learning objective. Assuming the group is large enough and/or highly paid, the time savings of adaptive learning may outweigh development costs. Likewise, if you have a heterogeneous audience and it is critical that all participants reach a minimum level of competence, adaptive learning can adjust the difficulty and level of support needed to ensure universal goal achievement.

**Learner Control Principle 4: Give Pacing Control**

Most asynchronous e-learning programs allow learners to proceed at their own pace by pressing the “forward” button. Video or animated demonstrations typically have slider bar controls indicating progress as well as “replay” and “quit” options. Research by Mayer and Chandler (2001), Mayer, Dow, and Mayer (2003), and Mayer and Jackson (2005) summarized in Chapter 10 recommends that asynchronous e-learning be divided into small chunks
that learners access at their own pace. In Chapter 10 we refer to this guideline as the segmenting principle.

Tabbers and de Koeijer (2010) revisited pacing control by comparing learning between two versions of the lightning lesson we illustrated in Figure 10.2. In the program-control version, sixteen narrated slides were shown for thirteen seconds each, after which the next slide was automatically displayed. The learner-controlled version shown in Figure 14.6 included the same slides but allowed the following interruptions: (1) stop and replay, (2) replay of the audio narration, or (3) selection of specific slides from a left menu. Similar to the Mayer and Chandler (2001) study, they found that transfer learning was better from the learner-controlled version. The participants in the learner-controlled version spent an average of almost three times longer than those using the program-controlled versions. This additional time was primarily used to re-inspect slides previously seen by using the left navigation menu and repeating the audio narration. The research team concluded that adding learner control to an animated instruction can increase understanding, but the tradeoff is additional time taken with the learning materials. Recall from Chapter 10 that Schar and Zimmermann’s 2007 research recommends that you automatically stop an animation at logical points and allow the learners to replay or continue from that point, rather than relying on the learners to use the pause and replay buttons on their own.

Figure 14.6. A Screen from a Learner-Controlled Version of the Lightning Lesson.

From Tabbers and de Koeijer, 2010.
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Learner Control Principle 5: Offer Navigational Support in Hypermedia Environments

Screen titles, embedded topic headers, topic menus, course maps, links, and movement buttons (forward, backward, and exit) are common navigational elements that influence comprehension. What evidence do we have for the benefits of various navigational elements commonly used in e-learning and hypermedia reference materials?

Use Headings and Introductory Statements

Content representations such as headings and introductory sentences improve memory and comprehension in traditional text documents. For example, Lorch, Lorch, Ritchey, McGovern, and Coleman (2001) asked readers to generate summaries of texts that included headings for half of the paragraphs. They found that the summaries included more content from paragraphs with headers and less from paragraphs lacking headers. Mayer (2005b) refers to headings as a form of signaling—providing cues concerning the important information in a lesson. We recommend that similar devices be used in e-learning programs. Screen headings, for example, might include the lesson title followed by the topic. On-screen text segments and visuals should likewise be signaled with brief descriptive labels similar to paper documents.

Use Links Sparingly in Lessons Intended for Novice Learners

Use links that take the learner off the teaching screen as well as links leading to important instructional events sparingly. By definition, links signal to the user that the information is adjunct or peripheral to the main content of the site. Learners will bypass many links. Based on the research described previously, we discourage using links for access to essential skill-building elements such as worked examples or practice, especially with novice audiences.

Neiderhauser, Reynolds, Salmen, and Skolmoski (2000) presented two related concepts in two separate lessons. In each lesson, links led learners to correlated information about the concept in the other lesson. For example, if reading about the benefits of concept A in Lesson 1, a link would bring...
up benefits of Concept B in Lesson 2 for purposes of contrast. They found that nearly half the learners frequently made use of these links. The other half either never used the links or used them briefly before abandoning them in favor of a more linear progression whereby they moved through one lesson from start to finish before moving to the other. Contrary to the authors’ expectations, they found that extensive use of the links was negatively related to learning. They attribute their findings to adverse impact of hypertext navigation on cognitive load.

If, however, your materials do include links, Shapiro (2008) suggests adding annotations to the links that will give novice learners a short preview of what is behind the link or to judiciously highlight links that are especially relevant to a specific learning goal.

Use Course and Site Maps

A course or site map is a type of menu or concept map that graphically represents the topics included in a course or reference resource. Nilsson and Mayer (2002) define a concept map as “a graphic representation of a hypertext document, in which the pages of the document are represented by visual objects and the links between pages are represented by lines or arrows connecting the visual objects” (p. 2). Figure 14.7 shows three different formats for course maps.

Figure 14.7. Three Map Layouts.

Research has been mixed on the contribution of course maps to learning. Neiderhauser, Reynolds, Salmen, and Skolmoski (2000) included a topic map containing a graphic representation of the hierarchical structure of the hypertext. Learners could access any screen in the hypertext from the topic map. A trace of user paths found that many learners did access the topic map frequently but rarely used it to navigate. Most would access the map, review the levels, and return to where they were reading. A few participants never accessed the topic map. In correlating map use with learning, the research team found only a slight benefit.

Potelle and Rouet (2003) compared comprehension of a hypertext between novice and content specialists for the three menu layouts shown in Figure 14.7: a hierarchical map, a network map, and an alphabetical list. Low knowledge participants learned most from the hierarchical map whereas the type of map made no difference to high prior knowledge participants. It may be that course maps are less important for navigational control than for providing learners, especially novice learners, with an orientation to the content structure. Novice learners may benefit most from such an orientation.

Shapiro (2005, 2008) compared learning from two versions of site maps for hypertext on a fictitious world of animals. One map version focused on animal categories. For example, a main menu item of reptiles included a submenu of desert shark, fat tail lizard, and so forth. The other map version focused on ecosystems. For example, a main menu item of desert included a submenu of long plume quail, fin lizard, and so forth. Half of the students were given learning goals pertaining to animal categories, whereas the other half were given goals pertaining to ecosystems. The focus of the map had a strong effect on learning, whereas the learning goals did not.

Shapiro (2008) suggests that site maps allow “learners to see the global structure of a hypermedia system, which is useful in that it provides a bird’s eye view of the landscape” (p. 35). She recommends that site maps be organized according to the learner’s goals. If the multimedia will include materials potentially relevant to many goals, a flexible site map could allow access from several different perspectives.
For example, the site map on the right-hand side of the screen in Figure 14.8 allows access according to eras, technologies, and social impact. It also illustrates link annotations in the lower left that will help learners know the content of a link destination.

We recommend the following guidelines regarding site maps:

- Consider using course maps or site maps for resources that are lengthy and complex and/or for learners who are novice to the content.
- Use a simple hierarchical structure.
- If your content will apply to learners with different tasks and instructional goals, consider multiple versions of a site map adapted to the instructional goals.

Figure 14.8. A Flexible Site Map with Link Explanations.
Provide Basic Navigation Options

In asynchronous e-learning, make elements for forward and backward movement, replay of audio and video, course exit, and menu reference easily accessible from every display. In courses that use scrolling pages, navigation should be accessible from both the top and bottom of the page to avoid overloading learners with unnecessary mouse work (having to scroll back to the top of the page to click “next”). Additionally, some sort of a progress indicator such as “Page 1 of 10” or a progress bar is useful to learners so that they know where they are in a topic and how far they have to go to complete it.

What We Don’t Know About Learner Control

Although we have seen evidence that learners low in prior knowledge or metacognitive skills benefit from program control, we need to know more about the relationship between prior knowledge, metacognitive skills, and various navigational control options. For example, do high metacognitive skills override low prior knowledge? Do learners with high metacognitive skills benefit from a different type of navigational support than those with low metacognitive skills?

Although adaptive e-learning seems to have advantages compared to program control or learner control, we need more information on the cost benefit of dynamic adaptation. Under what circumstances will the resource investment made in adaptive designs pay off in more efficient learning outcomes?

How should navigational elements such as site maps, lesson menus, or lesson topics be displayed? Is a left or right screen display more effective? Will a drop-down course map be as effective as an on-screen menu? Are on-screen tabs that chunk topics but still maintain context more effective than placing topics on separate screens?
**DESIGN DILEMMA: RESOLVED**

Ben and Reshmi’s disagreement about the amount and type of learner control to use in the spreadsheet lesson led to the following options:

A. Ben is correct. Millennials are experienced with high levels of learner control and will be turned off by excessive guidance.

B. Reshmi is correct. Learners do not make good decisions about what to study and what to skip. Program control will result in better learning.

C. Reshmi and Ben can evaluate the background knowledge of their audience and determine whether adaptive control would be a cost-effective option.

If the learners have a mixed background and budget is low, we recommend providing learner control but ensuring that the default navigation leads to important instructional elements. In addition, frequent knowledge checks with feedback can help learners monitor their progress and make appropriate decisions. Alternatively, if budget and time allow, providing personalized adaptive lessons based on responses to self-explanation questions might lead to more efficient learning. However, if the learners will be primarily novice to the topic, the most cost-effective approach is a program-controlled design.

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**WHAT TO LOOK FOR IN e-LEARNING**

Consider high learner control when:

- Your content is relatively low in complexity and topics are not logically interdependent
- Your audience is likely to have high metacognitive or learning self-regulation skills
- Your audience is likely to have prior knowledge of the content
- Your lessons or courses are advanced so that learners have built a knowledge base
In Chapter 1 we distinguished between instructional goals that are procedural (near transfer) and those that are strategic or require problem solving (far transfer). Many perform e-learning courses currently in use are designed to teach procedural skills—especially computer skills such as the Excel lesson we have used in this book. What is the potential of e-learning to teach more complex problem-solving skills such as consultative selling? In the next chapter we look at this question.
Suggested Readings


