CHAPTER OUTLINE

Do Visuals Make a Difference?

Multimedia Principle: Include Both Words and Graphics

- Select Graphics That Support Learning

Some Ways to Use Graphics to Promote Learning

- Graphics to Teach Content Types
- Graphics as Topic Organizers
- Graphics to Show Relationships
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Applying the Multimedia Principle

USE WORDS AND GRAPHICS RATHER THAN WORDS ALONE

WHAT'S NEW IN THIS CHAPTER?

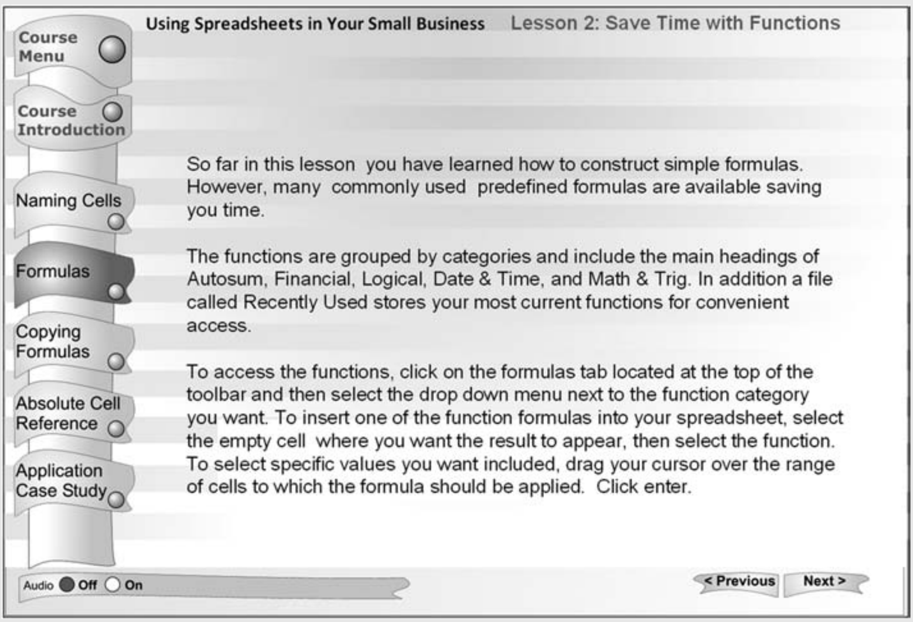
IN THE SECOND EDITION of this book we summarized evidence for learning gains that result from combining text and relevant graphics in e-lessons. In the past few years we see growing consensus for the multimedia principle as one of the most recognized principles of learning (Halpern, Graesser, & Hackel, 2007; Pashler, Bain, Bottage, Graesser, Koedinger, McDaniel, & Metcalfe, 2007). This chapter provides updated evidence and support for the multimedia principle and explores its boundary conditions. In particular, we provide evidence concerning (1) whether the multimedia principle depends on the experience level of the learners and (2) whether the multimedia principle depends on whether the graphics are static (illustrations or photos) or dynamic (animations or video). Another addition to this chapter involves a look at whether people learn better when graphic organizers are added to text.

DESIGN DILEMMA: YOU DECIDE

The new VP of corporate learning and performance is anxious to get started with the company's new e-learning initiative. She wants to show results quickly to offset upper management's impression that e-learning development is so slow that by the time it's released, it's already out of date. She has committed to an asynchronous course on Excel for Small Business to be ready in the next month. "After all", she says to Matt, the project lead, "We already have the content from our current instructor-led course. Let's quickly put it into e-learning!"

Ben, the project programmer, works quickly converting the classroom lecture notes into HTML. He proudly shows the team his first-draft storyboards, such as the one shown in Figure 4.1.

Figure 4.1. A Screen from Ben's First Draft of the Excel Course.



Reshmi, one of the course designers, reacts negatively: "Hey Ben, it's great that you got a draft together quickly since we don't have much development time. But this looks pretty boring to me! In e-learning the computer screen is our main connection with the students and screens filled with text will turn them off right away. We need this first project to be engaging. We need to add graphics and animations!" "Yeah," Ben replies. "Graphics are great but we don't have a graphic artist so, other than some screen grabs, I'll have to download some clip art." "Clip art is cheesy," Reshmi replies. "Let's contract an artist to create some custom Flash animations for us so we can really show what e-learning can do". Matt, the project manager, jumps in: "It will take time to get a contract set up and get the artist up to speed—time we don't have. Let's just start simple on this first project by going with mostly text with some screen grabs and one or two pieces of clip art here and there to add interest. We can try for a graphic artist on future projects. After all, basically our goal is to explain how small businesses can use Excel, and we can do that effectively with words." Based on your own experience or intuition, which of the following options is correct:

A. Matt is right. Learning will be just as effective from good textual explanations as from text plus graphics.

B. Ben is right. Adding clip art to a few screens will make the lesson more interesting. However, to save time, providing text alone will be as effective as adding visuals.

C. Reshmi is right. Customized visuals, including animations to demonstrate how to use Excel and to show how Excel works, will add appeal and improve learning.

D. Not sure which options are correct.

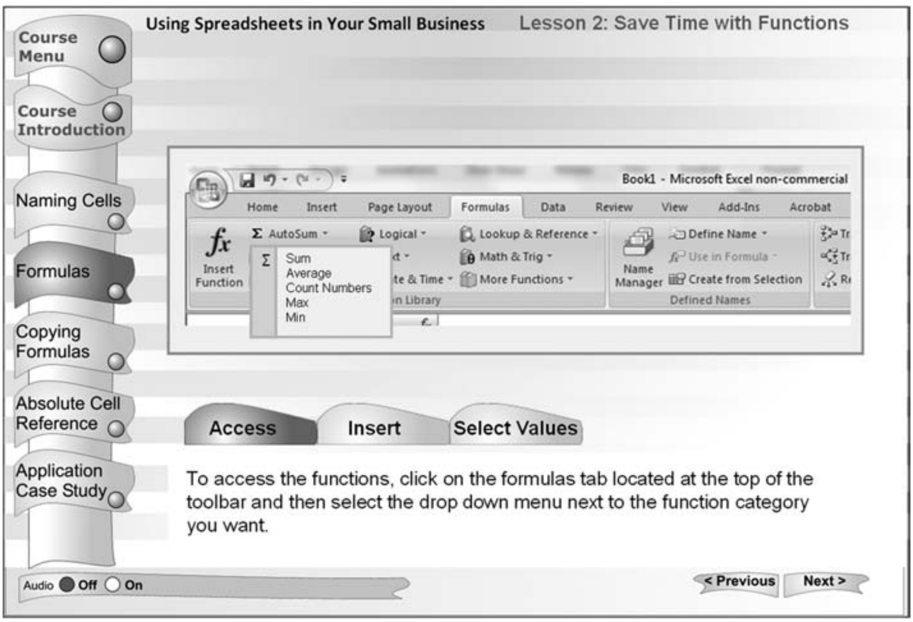
Do Visuals Make a Difference?

In training, it is customary to use words—either in printed or spoken form—as the main vehicle for conveying information. Words are quick and inexpensive to produce. The question is whether there is any return on investment for supplementing words with pictures—either static graphics such as drawings or photos, or dynamic graphics such as animation or video. In particular, do people learn more deeply from words and graphics than from words alone? This is the issue we want to explore with you in this chapter.

Multimedia Principle: Include Both Words and Graphics

Based on cognitive theory and research evidence, we recommend that e-learning courses include words and graphics rather than words alone. By words, we mean printed text (that is, words printed on the screen that people read) or spoken text (that is, words presented as speech that people listen to through earphones or speakers). By graphics we mean static illustrations such as drawings, charts, graphs, maps, or photos, and dynamic graphics such as animation or video. We use the term *multimedia presentation* to refer to any presentation that contains both words and graphics. For example, if you are given an instructional message that is presented in words alone, such as shown in Figure 4.1, we recommend you convert it into a multimedia presentation consisting of words and pictures, such as shown in Figure 4.2.

Figure 4.2. A Revision of Figure 4.1 with Visuals and Words.

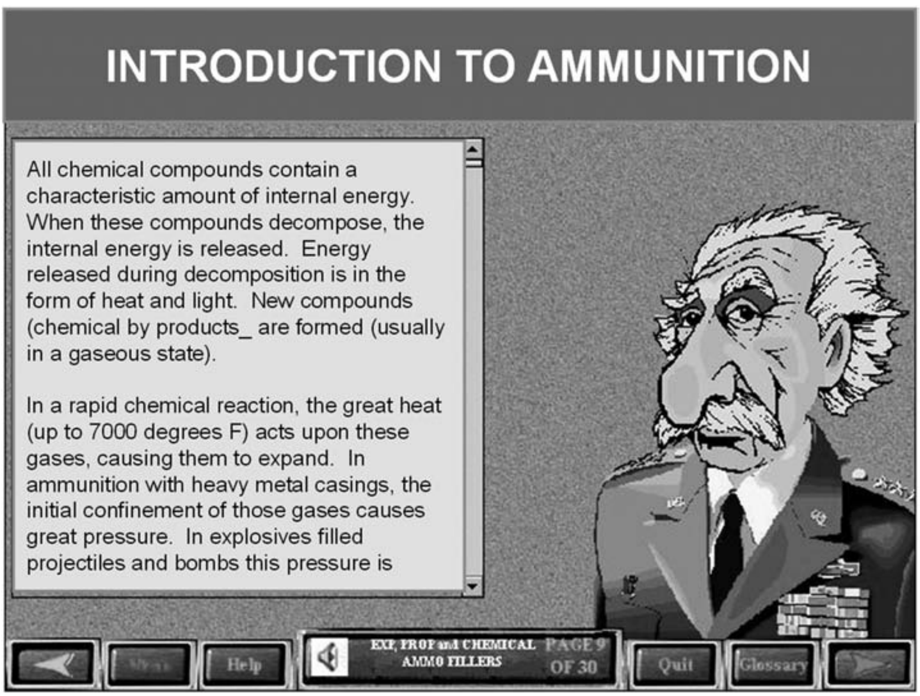


Pictures should not be an afterthought. Instead of selecting pictures after the words are written, instructional designers should consider how words and pictures work together to create meaning for the learner. Therefore, visuals as well as words should be planned together as the job analysis is conducted and the course is designed.

The rationale for our recommendation is that people are more likely to understand material when they can engage in active learning—that is, when they engage in relevant cognitive processing such as attending to the relevant material in the lesson, mentally organizing the material into a coherent cognitive representation, and mentally integrating the material with their existing knowledge. Multimedia presentations can encourage learners to engage in active learning by mentally representing the material in words and in pictures and by mentally making connections between the pictorial and verbal representations. In contrast, presenting words alone may encourage learners—especially those with less experience or expertise—to engage in shallow learning such as not connecting the words with other knowledge.

There are many examples of e-learning environments that contain window after window of text and more text. Some may even have graphics that decorate the page, but do not help you understand the text. For example, Figure 4.3

Figure 4.3. A Decorative Graphic That Does Nothing to Improve Learning.



from a military course on ammunition presents scrolling text and a picture of a general as a decorative element. As you can see, the general graphic does not support the text, but rather simply serves to decorate screen space.

Select Graphics That Support Learning

Instead of presenting words alone, we recommend presenting words and graphics. However, not all kinds of graphics are equally helpful. For example, let's consider several possible functions of graphics:

1. *Decorative graphics* serve to decorate the page without enhancing the message of the lesson, such as photo or a video of person riding a bicycle in a lesson on how bicycle tire pumps work.
2. *Representational graphics* portray a single element, such as photo of the bicycle tire pump along with a caption, "Bicycle Tire Pump."
3. *Relational graphics* portray a quantitative relationship among two or more variables, such as a line graph showing the relation between years of age on the x-axis and probability of being in a bicycle accident on the y-axis.
4. *Organizational graphics* depict the relations among elements, such as a diagram of a bicycle tire pump with each part labeled or a matrix giving a definition and example of each of three different kinds of pumps.
5. *Transformational graphics* depict changes in an object over time, such as a video showing how to fix a flat tire, or a series of annotated frames showing stages of how a bicycle tire pump works.
6. *Interpretive graphics* illustrate invisible relationships such as an animation of the bicycle pump that includes small dots to show the flow of air into and out of the pump.

Based on this analysis, we recommend that you minimize graphics that decorate the page (*decorative graphics*) or simply represent a single object (*representational graphics*), and that you incorporate graphics that help the learner understand the material (*transformational* and *interpretive graphics*) or organize the material (*organizational graphics*). For example, Table 4.1 is an organizational graphic that gives the name, definition, and example of six functions of graphics in the form of a matrix. When the text describes a quantitative

Table 4.1. An Organizational Graphic of Graphic Types.

Adapted from Clark and Lyons, 2011.

Graphic Type	*Description*	*Examples*
Decorative	Visuals added for aesthetic appeal or for humor	1. The general in Figure 4.3 2. A person riding a bicycle in a lesson on how a bicycle pump works 3. Baseball-related icons as a game theme in a lesson on product knowledge
Representational	Visuals that illustrate the appearance of an object	1. The screen capture in Figure 4.2 2. A photograph of equipment in a maintenance lesson
Organizational	Visuals that show qualitative relationships among content	1. A matrix such as this table 2. A concept map 3. A tree diagram
Relational	Visuals that summarize quantitative relationships	1. A bar graph or pie chart 2. A map with circles of different sizes representing location and strength of earthquakes
Transformational	Visuals that illustrate changes in time or over space	1. An animated demonstration of a computer procedure 2. A video of how volcanoes erupt 3. A time-lapse animation of seed germination
Interpretive	Visuals that make intangible phenomena visible and concrete	1. Drawings of molecular structures 2. A series of diagrams with arrows that illustrate the flow of blood through the heart 3. Pictures that show how data is transformed and transmitted through the Internet

relationship, then a *relational graphic* is warranted; and when the text describes changes over time, then a *transformational graphic* is warranted.

In Chapter 2, we summarized the dual channels principle that learners have separate channels for processing verbal material and pictorial material. We see the job of an instructional professional as not just to present information—such as presenting text that contains everything the learner needs to know—but rather to leverage both channels in ways that enable the learner to make sense out of the material.

In Chapter 1, we introduced the engagement matrix. Relevant visuals are one powerful method to support psychological engagement in the absence of behavioral activity. In other words, visuals are one instructional method that falls into the upper left cell of the matrix shown in Figure 1.5. Providing relevant graphics with text is a proven method of fostering deeper cognitive processing in learners. In short, learning is facilitated when the graphics and text work together to communicate the instructional message.

Some Ways to Use Graphics to Promote Learning

Helping you determine how to create the best types of graphics to meet your instructional goals requires a book in itself. In fact, just such a book is *Graphics for Learning* (2nd ed.) by Ruth Colvin Clark and Chopeta Lyons. Here we offer just a few examples of the ways to use graphics that serve instructional rather than decorative roles: to teach content types, as topic organizers, and as lesson interfaces.

Graphics to Teach Content Types

Clark (2008) has identified five different kinds of content: fact, concept, process, procedure, and principle. Table 4.2 briefly describes each content type and lists graphic types commonly used to teach specific lesson content such as facts, concepts, processes, procedures, and principles.

Since 63 percent of computer-systems training is delivered by e-learning (ASTD, 2010), many e-learning graphics are screen captures. A screen capture is a graphic that is a replication of an actual software screen. For example, Figure 4.4 is a screen capture from a synchronous e-learning class on Excel. At this point in the lesson, the instructor uses the application-sharing feature of the virtual classroom to demonstrate how to use formulas in Excel. Another content type that profits from graphic support is process. A

Table 4.2. Graphics to Teach Content Types.

Adapted from Clark, 2008.

Content Type	*Description*	*Useful Graphic Types*	*Example*
Facts	Unique and isolated information such as specific application screens, forms, or product data	Representational, Organizational	A screen capture as in Figure 4.2 A table of parts' names and specifications
Concepts	Categories of objects, events, or symbols designated by a single name	Representational, Organizational, Interpretive	A tree diagram of biological species Three Excel formulas to illustrate formatting rules
Process	A description of how something works	Transformational, Interpretive, Relational	Animations of how the heart pumps blood Still diagrams to illustrate how a bicycle pump works An animation showing how a virus invades a cell as in Figure 4.5
Procedure	A series of steps resulting in completion of a task	Transformational	An animated illustration of how to use a spreadsheet as in Figure 4.4 A diagram with arrows showing how to install a printer cable
Principle	Guidelines that result in completion of a task; cause-and-effect relationships	Transformational, Interpretive	A video showing two effective sales approaches An animation showing genes passing from parents to offspring

Figure 4.4. A Transformation Visual of an Excel Demonstration in Synchronous e-Learning.

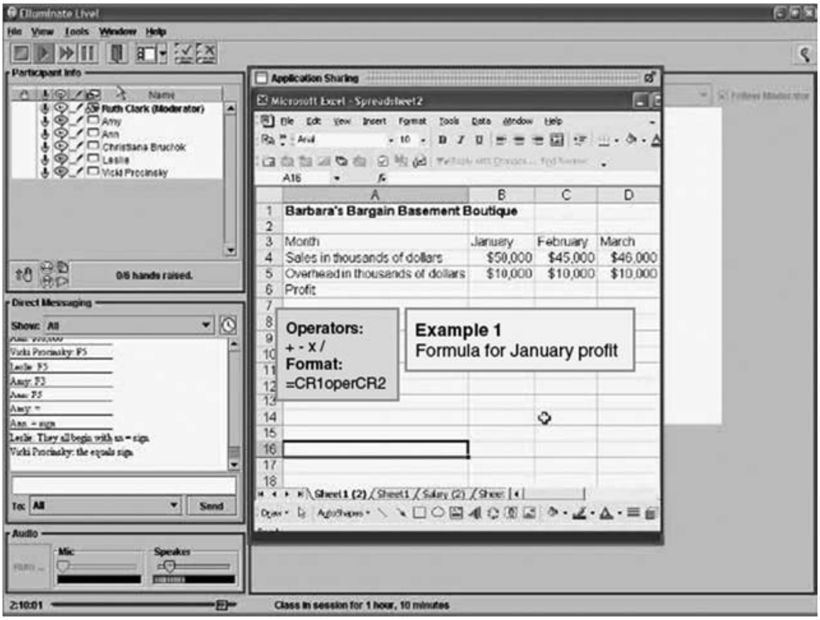


Figure 4.5. An Interpretive Graphic Illustrating the Process of AIDS Infection.

With permission of Roche, Basel, Switzerland. Http://www.roche-hiv.com/front.cfm.

process is a step-by-step description of how a system works, including business, scientific, and mechanical systems. Process information is effectively visualized with a series of static frames or, in some cases, animations. Figure 4.5 is a screen from an animated graphic showing how the AIDS virus infects cells.

Graphics as Topic Organizers

In addition to illustrating specific content types, graphics such as topic maps can serve an organizational function by showing relationships among topics in a lesson. For example, Figure 4.6 shows a screen with a series of coaching topics mapped in the left-hand bar, including where to coach, when to coach, how long to coach, and so on. When the mouse is placed over each of the topics in the graphic organizer, a different illustration appears on the right side of the screen. In this example, the topic of formal and informal coaching sessions is explained with text and photographs.

Figure 4.6. An Organizational Graphic on Coaching Topics.

Graphics to Show Relationships

Graphics in the form of dynamic and static graphs can make invisible phenomena visible and show relationships. Imagine an e-learning lesson to teach fast-food workers safe cooking and food-handling practices. An animated line graph with numbers on the vertical axis and time on the horizontal axis illustrates changes in bacterial growth in food cooked at different temperatures or handled in safe and unsafe ways. The lesson includes an interactive simulation in which the learner adjusts the cooking temperature and sees the impact on a dynamic line graph called a "germ meter." As another example, a geographic map can illustrate population density by adding a small red dot to represent five thousand individuals. If made interactive, the map could include a slider bar that accessed different time periods allowing the viewer to see population shifts over time.

Graphics as Lesson Interfaces

Finally, courses designed using a guided discovery approach often use a graphical interface as a backdrop to present case studies. For example, in Figure 1.6 we showed an interface for a troubleshooting course for automotive technicians. The virtual shop includes most of the testing tools available in a normal shop, allowing the learner to run and interpret tests to diagnose and repair an automotive failure.

Psychological Reasons for the Multimedia Principle

Perhaps the single greatest human invention is language, and the single greatest modification of this invention is printed language. Words allow us to communicate effectively, and printed words allow us to communicate effectively across miles and years. (So does recorded speech, by the way, which is yet another modification of the great invention of language.) Therefore, it makes sense to use words when we provide training or instruction. For thousands of years, the main format for education has been words—first in spoken form and more recently in printed form (and recorded form). Words are also the most efficient and effective way of producing e-learning because words can convey a lot of information and are easier to produce than graphics.

This line of thinking is based on the information acquisition view in which teaching consists of presenting information and learning consists of acquiring information, as summarized in the middle of Table 2.1. Information can be delivered in many forms—such as printed words, spoken words, illustrations, photos, graphs, animation, video, and narration. Over the years, it has become clear that words are an efficient and effective method for presenting information, so based on this view, in most situations instruction should involve simply presenting words. According to the information acquisition view, the format of the information (for example, words versus pictures) does not matter, as long as the information is delivered to the learner.

In our opinion, the information acquisition view is based on an inadequate conception of how people learn. Instead, we favor a knowledge construction view in which learning is seen as a process of active sense-making and teaching is seen as an attempt to foster appropriate cognitive processing in the learner, as summarized in the bottom of Table 2.1. According to this learning metaphor, it is not good enough to deliver information to the learner; instructors must also guide the learner's cognitive processing during learning, thereby enabling and encouraging learners to actively process the information. An important part of active processing is to mentally construct pictorial and verbal representations of the material and to mentally connect them. This goal is more likely to be achieved with multimedia lessons containing both words and corresponding pictures that work together to explain the same to-be-learned content. Adding relevant graphics to words can be a powerful way to help learners engage in active learning. Overall, your view of the cognitive stages of how learning works (as summarized in Table 2.1) can influence your decisions about how to design instruction (Mayer, 2003).

Evidence for Using Words and Pictures

There is consistent evidence that people learn more deeply from words and pictures than from words alone, at least for some simple instructional situations. In eleven different studies, researchers compared the test performance of students who learned from animation and narration versus narration alone or from text and illustrations versus text alone (Mayer, 1989b; Mayer & Anderson, 1991, 1992; Mayer, Bove, Bryman, Mars, & Tapangco, 1996; Mayer & Gallini, 1990; Moreno & Mayer, 1999b, 2002b). The lessons taught scientific and mechanical processes, including how lightning works,

Figure 4.7. How a Bicycle Pump Works Explained with Words Alone.
From Mayer, 2009.

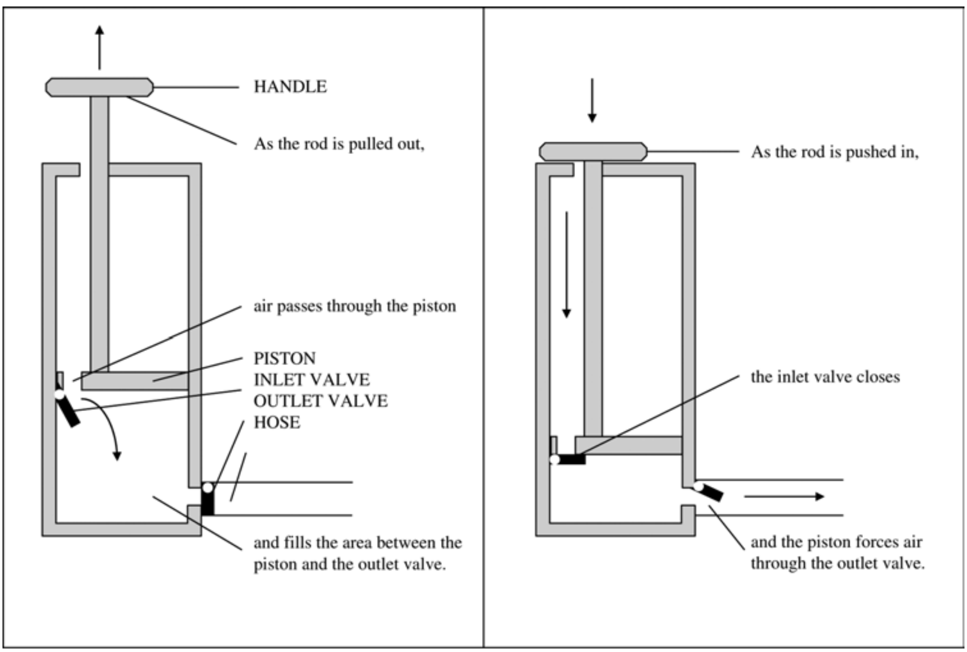
How a Bicycle Pump Works

"As the rod is pulled out, air passes through the piston and fills the area between the piston and the outlet valve. As the rod is pushed in, the inlet valve closes and the piston forces air through the outlet valve."

how a car's braking system works, how pumps work, and how electrical generators work. For example, in one study students read an accurate verbal description of how a bicycle pump works (as shown in Figure 4.7), while others read the same verbal description and viewed a diagram depicting the same steps (as shown in Figure 4.8).

In all eleven comparisons, students who received a multimedia lesson consisting of words and pictures performed better on a subsequent transfer test than students who received the same information in words alone. Across the eleven studies, people who learned from words and graphics produced

Figure 4.8. How a Bicycle Pump Works Explained with Words and Graphics.
From Mayer, 2009.



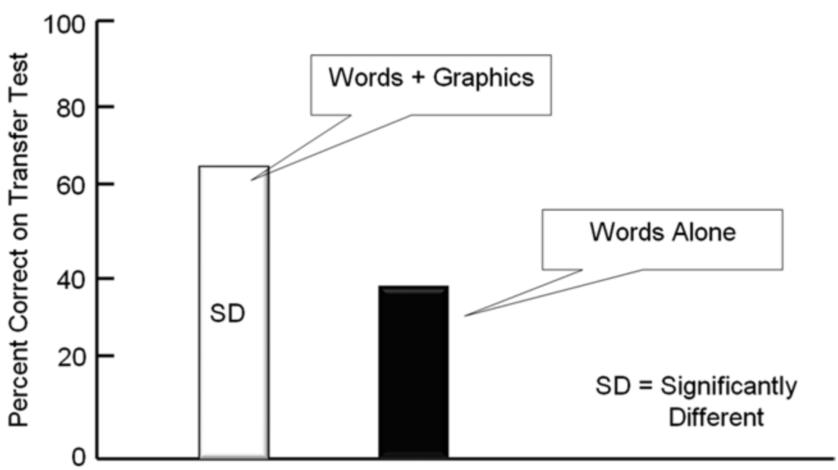
between 55 percent to 121 percent more correct solutions to transfer problems than people who learned from words alone. Across all studies, a median percentage gain of 89 percent was achieved with a median effect size of 1.50. Recall from our discussion in Chapter 3 that effect sizes over .8 are considered large. Figure 4.9 shows a result from one of these experiments. Similarly, Butcher (2006) found that people developed a deeper understanding of how the human heart works from text with simple illustrations than from text alone.

We call this finding the *multimedia effect*—people learn more deeply from words and graphics than from words alone. In a recent review, Fletcher and Tobias (2005, p. 128) concluded: "The multimedia principle, which suggests that learning and understanding are enhanced by adding pictures to text rather than presenting text alone, appears to be well supported by findings from empirical research." The multimedia effect is the starting point for our discussion of best instructional methods for e-learning because it establishes the potential for multimedia lessons to improve human learning.

In recent years, the multimedia principle has been recognized as one of the most well-established principles of learning that can be applied to education. For example, in their review of twenty-five "principles of learning" commissioned by the Association of Psychological Science, Halpern,

Figure 4.9. Learning Is Better from Words Plus Graphics Than from Words Alone.

Adapted from Mayer, 2001a.



Graesser, and Hakel (2007) listed the "dual code and multimedia effects" as the third principle on their list: "Information is encoded and remembered better when it is delivered in multiple modes . . . than when delivered in only a single mode." In a practical guide on "organizing instruction and study to improve student learning" commissioned by the Institute of Education Sciences, Pashler, Bain, Bottage, Graesser, Koedinger, McDaniel, & Metcalfe (2007) offered "combine graphics with verbal descriptions" as their third of seven recommendations. In short, there is consensus among learning scientists that the multimedia principle has promise for instructional design.

The multimedia principle can apply to the design of computer-based simulations and games. In a study involving interactive multimedia, Moreno and Mayer (1999b) developed a mathematics computer game intended to teach students how to add and subtract signed numbers (such as 2–3 = _______). Some students learned from drill-and-practice problems, whereas others worked on the same problems but as feedback also saw a bunny hop along a number line to represent each problem (such as starting at two, turning to face the left, hopping backward three steps, and landing on five). Students learned better with symbols and graphics than from symbols alone.

The multimedia principle can also apply to the design of what we defined previously as organizational visuals—that is, charts that summarize the text in spatial form such as a hierarchy, matrix, or flow chart. For example, Stull and Mayer (2007) found that adding graphic organizers to the margins of a biology text resulted in improved test performance. In a related study, students learned better from a science text if it was accompanied by a causal diagram that summarized the main relationships from the text (McCrudden, Schraw, & Lehman, 2009; McCrudden, Schraw, Lehman, & Poliquin, 2007).

Finally, the multimedia principle applies to video examples, in which students learned better from reading a lesson on teaching techniques followed by viewing video examples rather than reading a lesson followed by reading text-based descriptions of examples (Moreno & Ortegano-Layne, 2008).

In the remainder of this section, we consider two additional research questions, concerning for whom the multimedia principle works (for example, novices versus experts) and where the multimedia principle works (for example, static illustrations versus animations).

The Multimedia Principle Works Best for Novices

Does the multimedia principle apply equally to all learners? There is evidence that our recommendation to use words and graphics is particularly important for learners who have low knowledge of the domain (whom we can call *novices*) rather than learners who have high knowledge of the domain (whom we can call *experts*). For example, in a series of three experiments involving lessons on brakes, pumps, and generators, Mayer and Gallini (1990) reported that novices learned better from text and illustrations (such as shown in Figure 4.8) than from words alone (such as shown in Figure 4.7), but experts learned equally well from both conditions. Apparently, the more experienced learners are able to create their own mental images as they read the text about how the pump works, whereas the less experienced learners need help in relating the text to a useful pictorial representation.

In a related study, Ollerenshaw, Aidman, and Kidd (1997) presented text lessons on how pumps work to learners who had low or high knowledge of the domain. Low-knowledge learners benefited greatly when animation was added to the text, whereas high-knowledge learners did not. These and related results (Kalyuga, Chandler, & Sweller, 1998, 2000; Mayer & Gallini, 1990; Ollerenshaw, Aidman, & Kidd, 1997) led Kalyuga and colleagues (Kalyuga, 2005; Kalyuga, Ayres, Chandler, & Sweller 2003) to propose the *expertise reversal effect*—the idea that instructional supports that help low-knowledge learners may not help (and may even hurt) high-knowledge learners. Overall, we recommend that you be sensitive to the level of prior knowledge of your learners so that you can provide needed supports—such as multimedia instruction—to low-knowledge learners. If you are working on a course for a less advanced group of learners—beginning trainees, for example—you should be especially careful to supplement text-based instruction with coordinated graphics. If you have a more advanced group of learners, such as medical residents or engineers experienced in the topic you are presenting, they may be able to learn well mainly from text or even mainly from graphics.

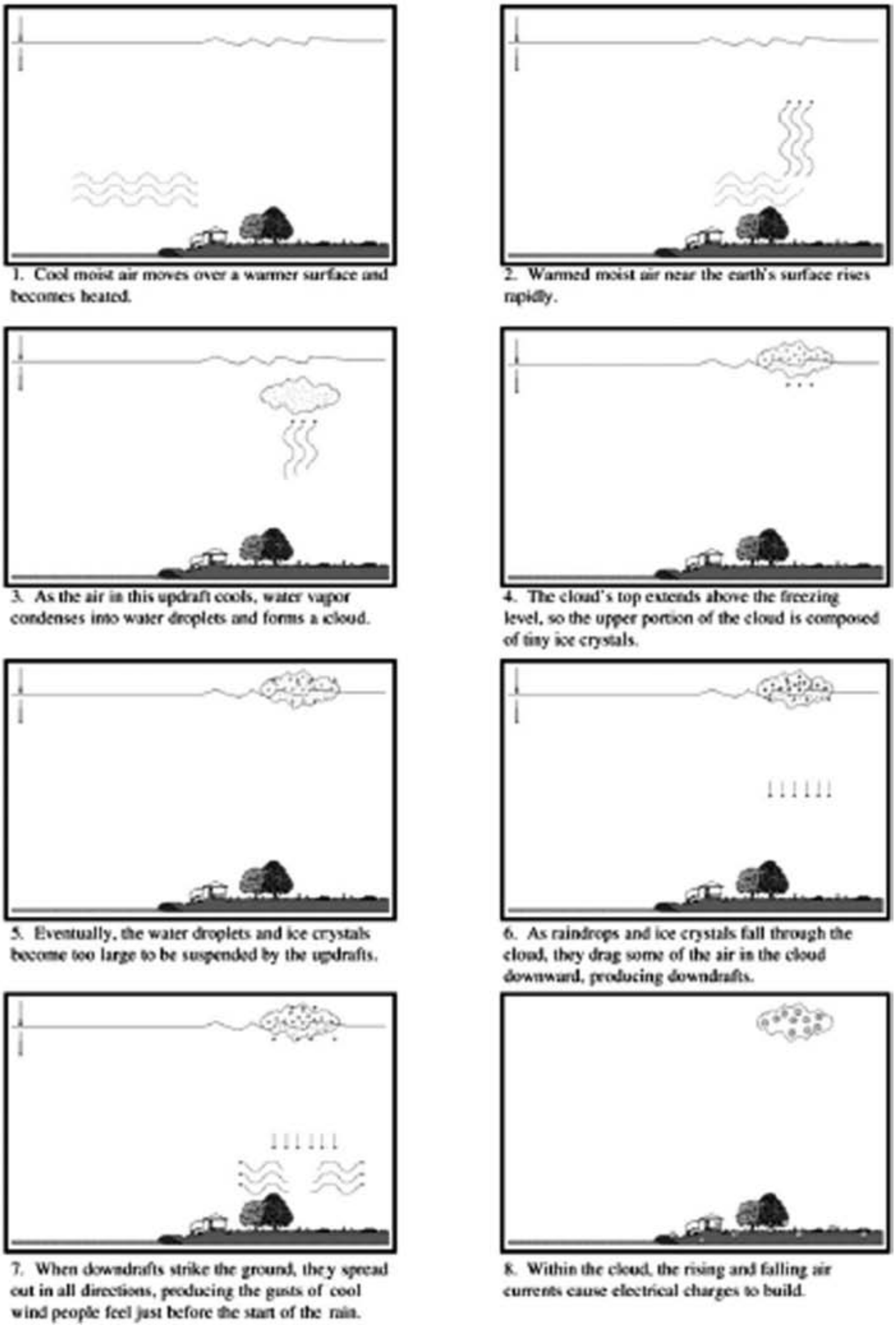
Should You Change Static Illustrations into Animations?

If it is important to add graphics to words, is it better to use animations or to use static illustrations? Flash animations are currently very popular additions to many e-learning lessons. At first glance, you might think that animations are best because they are an active medium, which can depict changes and movement. Similarly, you might think that static illustrations are a poorer choice because they are a passive medium, which cannot depict changes and movement in as much detail as animations can. In spite of these impressions, a number of research studies have failed to find that animations are more effective than a series of static frames depicting the same material (Betrancourt, 2005; Hegarty, Kriz, & Cate, 2003; Mayer, Hegarty, Mayer, & Campbell, 2005; Tversky, Morrison, & Betrancourt, 2002).

Let's consider two ways to use multimedia to explain how lightning storms develop—a paper-based lesson of a series of static illustrations with printed text (as shown in Figure 4.10) or a computer-based lesson of narrated animations in which the words are spoken and the transitions between frames are animated. On a transfer test, students in the paper group performed 32 percent better than students in the computer group, yielding an effect size of .55 (Mayer, Hegarty, Mayer, & Campbell, 2005). In four such comparisons—involving lessons on lightning, ocean waves, hydraulic brakes, and toilet tanks—the illustrations-and-text group always performed better than the animation-and-narration group, yielding a median effect size of .57. Presumably, the so-called passive medium of illustrations and text actually allowed for active processing because the learners had to mentally animate the changes from one frame to the next and learners were able to control the order and pace of their processing. In contrast, the so-called active medium of animations and narration may foster passive learning because the learner did not have to mentally animate and could not control the pace and order of the presentation. In addition, animation may overload the learner's working memory because the images are so rich in detail and are so transitory that they must be held in memory. In contrast, a series of static frames does not impose extra cognitive load because the learner can always review a previous frame.

Figure 4.10. A Series of Static Visuals to Teach How Lightning Forms.

From Mayer, Hegarty, Mayer, and Campbell, 2005.



In spite of these results, there may be some content that is particularly suited to animation or video rather than static frames of illustrations or photos, such as descriptions of how to perform a motor skill. There is some evidence that animations (or video) may be particularly helpful for tasks that require complicated manual skills. For example, animation was more effective than static diagrams in helping students learn to make paper flowers and hats through paper folding (ChanLin, 1998; Wong, Marcus, Ayres, Smith, Cooper, Paas, & Sweller, 2009) and in helping students learn to tie knots and complete puzzle rings (Ayres, Marcus, Chan, & Qian, 2009). In contrast, studies in which static diagrams are better or just as effective as animations tend to involve explanations of how a complex system works, such as a braking system or how ocean waves work. In other words, it appears that static visuals might be most effective to promote understanding of processes, whereas animated visuals may be more effective to teach hands-on procedures.

Additionally, animations can serve an interpretive function when designed with special effects that reveal relationships not otherwise visible.

Hegarty (2004) suggests that "dynamic displays can distort reality in various ways such as slowing down some processes and speeding up others, showing an object or phenomenon from different or changing viewpoints, augmenting the display with cues to draw viewers' attention to the most relevant parts, or having moving objects leave a trace or wake" (p. 345). A time-lapse video of seed germination or a slow-motion video of hummingbirds in flight are two examples of how special effects can make phenomena visible.

Animations can cost more to develop than static diagrams, so it makes sense to use a series of static frames as our default graphic. Overall, our recommendation is to use static illustrations unless there is a compelling instructional rationale for animation. In particular, when you have an explanative illustration, we recommend presenting a series of static frames to depict the various states of the system rather than a lock-step animation.

What We Don't Know About Visuals

We have good evidence that relevant visuals promote learning. Now it's time to find out more about what types of visuals are most effective for different learners and instructional goals. Some of the unresolved issues around graphics include:

1. When is an animation more effective than a static graphic?
2. What are the long-term effects of graphics? Most of our research data measures learning immediately after taking the lesson. We need more information on the effectiveness of visuals for longer term learning.
3. What is the return on investment of graphics? Explanatory visuals can be time-consuming to produce and require an investment in graphic design resources. What are the cost benefits for creating customized visuals to illustrate technical content?

DESIGN DILEMMA: RESOLVED

In our chapter introduction, you considered the following options for use of graphics in the database course:

A. Matt is right. Learning will be just as effective from good textual explanations as from text plus graphics.

B. Ben is right. Adding clip art to a few screens will make the lesson more interesting. However, to save time, providing text alone will be as effective as adding visuals.

C. Reshmi is right. Customized visuals including screen shot animation demonstrations to illustrate the content will add appeal and improve learning.

D. Not sure which options are correct.

Based on the evidence we presented in this chapter, we conclude that Reshmi is on the right track. e-Learning is a visual medium and relevant graphics will add appeal and improve learning. The lesson segments that involve Excel procedures might benefit from animated demonstrations. However, lesson sections that explain Excel concepts and processes will benefit as much from static graphics. Ben's idea to add decorative graphics in the form of clip art will most likely not contribute to learning and in fact, as we will see in Chapter 8 on the coherence principle, may even detract from learning. We recommend that the team use an authoring system to capture animated screen procedures and engage a graphic designer to create a few simple but functional visuals to support the lesson concepts—including visuals that serve organizational, transformational, and interpretive functions. Even if a few extra days are required, the improvement in instructional quality and appeal is worth the investment.

WHAT TO LOOK FOR IN e-LEARNING

- ☐ Graphics and text are used to present instructional content.
- ☐ Graphics are relevant to the instructional purpose rather than decorative.
- ☐ Representative graphics are used to illustrate concrete facts, concepts, and their parts.
- ☐ Animations are used primarily to illustrate hands-on procedures.
- ☐ Organizational graphics are used to show relationships among ideas or lesson topics or where the parts are located within a whole structure.
- ☐ Relational graphics are used to show quantitative relationships among variables.
- ☐ Transformational graphics, such as a video showing how to operate equipment, are used to show changes over time.
- ☐ Interpretive graphics, such as a series of static frames, are used to explain how a system works or to make invisible phenomena visible.
- ☐ Graphics are used as a lesson interface for case studies.

COMING NEXT

In this chapter we have seen that learning is improved by the use of relevant graphics combined with words to present instructional content. In the next chapter, we will build upon this principle by examining the contiguity principle that addresses the best ways to position graphics and related text on the screen.

Suggested Readings

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