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THE eLEARNING DEVELOPERS' JOURNAL™

Strategies and Techniques for Designers, Developers, and Managers of eLearning

THIS WEEK — DESIGN TECHNIQUES

More Than Just Eye Candy: Graphics for e-Learning

Part 1 of 2 parts

BY RUTH COLVIN CLARK

Everyone has an opinion about graphics. And more often than not, those opinions are simultaneously diverse and intense! There is no doubt that visuals grab our attention and command a response. But how do you know that the visuals included in your e-Learning lessons actually improve learning? That's why my colleague Chopeta Lyons and I recently completed a book on graphics based on research evidence that provides practitioners with guidelines for planning and designing the best graphics in their training materials. Here are some tips from the book that you may find useful.

Because it's such a visual medium, it's too bad that e-Learning so often fails to leverage the potential of graphics to promote learning. In some cases, e-Lessons are what our colleague Frank Nguyen of Intel calls *A Wall of Words*. (See Figure 1 on page 2.) Because words are quick and easy to produce, and because we have all devoted lifetimes of learning and practice perfecting our use of language, all too many e-Lessons include no visuals or at best, only a few decorative visuals.

At the other extreme some e-Courses use elaborate visual treatments to produce what I call *Las Vegas-style* courseware. By embedding dry technical content in exotic and visually rich fantasy or game themes, the

Continued on next page

Visuals included in your e-Learning can improve learning — if you can figure out how to use them correctly. In this, the first of two parts, two experts guide you through the results of research into the best practices. This is an article you will want to refer to often!

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As in any profession, there are many different perspectives about the best strategies, techniques and tools one can employ to accomplish a specific objective. This **Journal** will share these different perspectives and does not position any one as "the right way," but rather we position each article as "one of the right ways" for accomplishing a goal. We assume that readers will evaluate the merits of each article and use the ideas they contain in a manner appropriate for their specific situation. We encourage discussion and debate about articles and provide an Online Discussion board for each article.

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developers try to make the learning experience more motivating. I've seen system application courses wrapped in a fantasy-adventure such as Terminator and new hire orientation embedded in a treasure hunt. (See Figure 2 on page 3.) Elaborate visual treatments unrelated to the goals of the instruction, while well-intended, have been shown in controlled research studies to depress learning.

Both under-use and over-use of visuals fail to deliver the potential of graphics to support learning. So, just what makes a good graphic in e-Learning? Over the past 15 years, a considerable body of relevant research on the best use of visuals to promote learning has accumulated. However, most of this research is published in diverse academic journals not generally read by training professionals. Additionally, the research reports do not provide examples of how to apply the guidelines in training settings.

Do graphics improve learning?

The answer is — it depends! Many studies that compared lessons that used text alone to teach content with lessons that added relevant visuals to the text have shown that the versions with graphics do improve learning. Richard Mayer reported an average learning gain of 89% in lesson versions that added *relevant* visuals to text. Note the emphasis on the word "relevant"!

Three factors that shape graphic effectiveness

Not all graphics are equally effective. In fact, research reported in the *Journal of Educational Psychology* as long ago as 1998 shows that some visuals can actually depress learning compared to lessons that used text alone. So how can you plan and design graphic treatments for your e-Learning that are likely to enhance learning outcomes? Our research uncovered three main factors, illustrated in Figure 3 on page 3, that shape the effectiveness of your visual treatments:

- the instructional goal,
- the learning landscape,
- and features of the graphic itself.

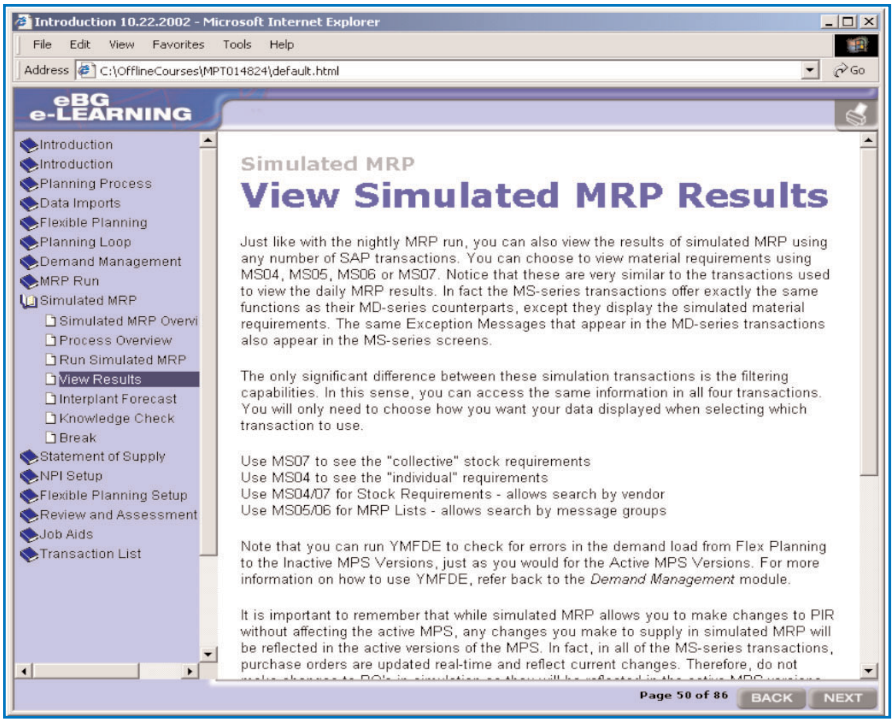

FIGURE 1 *A screen from a "wall of words" course*

Factor 1: Goals of the instruction. In *E-Learning and the Science of Instruction*, Rich Mayer and I describe three main instructional goals for e-Learning:

- to inform,
- to support procedural (routine task) performance,
- and to support principle-based (non-routine task) performance.

Many courses incorporate all three goals. Usually however one of the three predominates. For example, many e-Learning courses are designed to teach systems applications. These are procedural courses. Most also have subgoals of informing learners about the application and its benefits to their work. But the main goal is to teach how to use the system.

Other e-Courses attempt to teach what we call far-transfer tasks — tasks which require employee judgment because the worker will always have to adapt guidelines to unique job situations. Many so-called soft-skills such as negotiation, selling, and supervision fall into this category. Both procedural and principle-based courses are designed to build skills and thus support job performance directly.

Courses that inform are developed primarily to build awareness and often to promote positive feelings. Courses on new employee orientation or lessons on new company policies often fall into this category.

The instructional goal is one major factor to consider in the planning and design of visuals for learning. For example, a procedural course is going to include many graphics that illustrate the screens or equipment being trained. In contrast, many principle-based courses use a problem-centered learning approach in which the visuals illustrate a job setting in which the learner gets a virtual task assignment and learns new skills while working the assignment. Figure 4 on page 4 shows a screen capture from a problem-centered learning course designed to teach bank agents how to assess a commercial loan.

Factor 2: The learning landscape. All visuals for training purposes will be displayed in some medium such as a workbook, a job card or on a computer screen. Likewise they will be presented in a specific instructional environment such as a job card affixed to equipment, or a slide projected in a classroom. e-Learning platforms offer various capabilities to display visuals and words depending on issues such as bandwidth, presence of sound cards, availability of headsets etc. Of course training programs are designed for specific groups of learners whose background and aptitudes also shape

FIGURE 2 *An exotic fantasy theme used for edutainment. (Credit: Mark A. Palmer)*

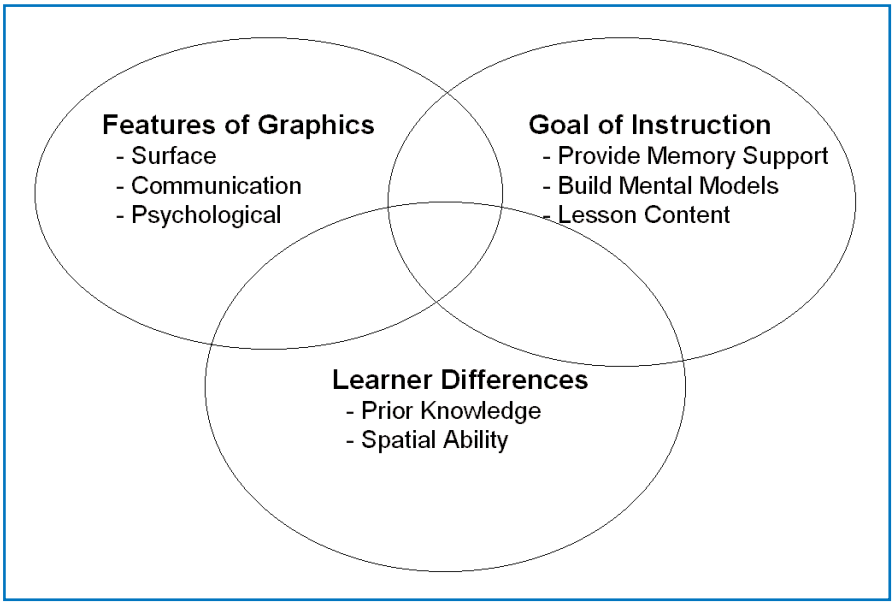

FIGURE 3 *Three factors that shape design of effective visuals. © Ruth Clark and Chopeta Lyons*

FIGURE 4 *A virtual workplace serves as a visual backdrop for problem-centered learning. (With permission from Moody's Financial Services.)*

decisions about visuals. How much prior knowledge the audience has about the content and their spatial ability are two proven factors that influence the type of graphic that will improve learning. Last we can't forget the practical realities of every project — things like budget, organizational standards and guidelines, and resources for graphics production.

The combination of these environmental factors makes each graphic design project unique. The design and display of visuals for systems training intended for novice learners to be delivered on platforms with plenty of bandwidth and sound capability will be quite different from the design and display of visuals for systems training to be delivered in a workbook destined for either self-

study or classroom delivery. (See Figures 5 and 6 on page 7.) Juggling all of these factors to make the best graphics decisions for each project is best achieved with a systematic process for assessing the landscape. In Part 2 of this article, to be published in **The Journal** September 29, 2003, Chopeta Lyons will preview this model.

Factor 3: Features of the graphic. It's not surprising that features of the graphic itself will influence its learning effectiveness. What might be surprising however is that it's NOT the features you typically associate with graphics that determine their learning effectiveness. Usually we talk about graphics in terms of their surface features.

By surface features I refer to the salient appearance of a visual. Is it an animation? Is it a line drawing? Is it a photograph? And while surface features are important to production of your graphics, in most cases, it is not surface features alone that determine their effectiveness. Instead, it's the functionality of the graphic — both its communication and its psychological functionality. We recommend planning visuals based on how they communicate and how they work psychologically rather on their surface features. We propose that these functional taxonomies can give you a new grammar of visuals — a grammar that will help you make better decisions about how to use visuals for learning.

Surface features vs. functional features of graphics

A recent research study reported in the journal *Applied Cognitive Psychology* showed that people could learn a simple procedure (bandaging a hand) equally effectively from three different graphic treatments. As shown in Figures 7, 8, and 9 on page 8, all three treatments illustrated motion. Two were delivered on paper and one on video. The paper graphics were simple line drawings for which motion was communicated by text or line drawings alone. The video version used animation without sound to show the procedure.

> Many studies that compared lessons that used text alone to teach content with lessons that added **relevant** visuals to the text have shown that the versions with graphics do improve learning. Note the emphasis on the word "relevant"!

This research tells us that what causes learning is not the media — both video and paper worked fine; and it's not the surface features either — both line drawings and animation worked fine. Rather, it's the communication functionality of the graphic that matters. All three of these graphics belong in a category we call 'transformational' visuals. We define transformational graphics as any visual that shows movement through space or change over time. In the research study just referenced, the authors found that similar graphics that *were not transformational* resulted in significantly worse learning. For example, simple line drawings lacking motion descriptors in the form of words or arrows failed to support learning as effectively as the transformational visuals. Likewise, text alone that described the steps was not as effective as the transformational visuals.

TABLE 1 *A communication taxonomy for graphics for Learning*

Function	A graphic used to:	Examples
Decorative	Add aesthetic appeal or humor	• Art on the cover of a book • Visual of a general in a military lesson on ammunition
Representational	Depict an object in a realistic fashion	• A screen capture • A photograph of equipment
Mnemonic	Provide retrieval cues for factual information	• A picture of 10 forks stuck in a door to retrieve meaning of Spanish word for fork: Tenador
Organizational	Show qualitative relationships among content	• A two-dimensional course map
Relational	Show quantitative relationships among two or more variables	• A line graph • A pie chart
Transformational	Show changes in objects over time or space	• An animation of a weather cycle • A video showing how to operate equipment
Interpretive	Illustrate a theory or principle	• A schematic diagram of equipment • An animation of molecular movement

A communication taxonomy of visuals

While surface features are important for production purposes, the functionality of graphics is more important for learning. In *Graphics for Learning* we describe two taxonomies of visuals which we believe will help you plan and design graphics more effectively. One is based on communication functions and the other is based on psychological learning processes. In this article, I summarize the communication taxonomy.

Table 1 on page 5 summarizes six categories of visuals adapted from an article published last year in *Educational Psychology Review* that reflect communication purpose. Graphics of different surface features may fit into each category. Lets take a quick tour of these categories.

Decorative graphics. Decorative graphics are one of the most common types of visuals used in training materials. Their intended purpose is to build motivation by adding either aesthetics or humor to the instructional display. Figure 10 on page 9 shows one example. In general, decorative graphics serve no real instructional purpose. And when taken to extremes such as the fantasy theme visual shown earlier in Figure 2, they have been shown to depress learning. We recommend that decorative visuals be used sparingly in instructional materials.

Representational graphics. Along with decorative graphics, representational visuals are the other most common type of visual seen in training materials. As the name suggests, representational visuals are intended to depict the actual appearance of content. They can be presented in diverse surface features including photographs, screen captures, and line drawings.

Representational visuals are appropriately used to present concrete concepts and factual information related to job tasks such as sceens, forms, equipment, and common work settings. Figures 4 through 9 all include some type of representational graphic.

Mnemonic graphics. Occasionally workers must recall factual information and cannot have access to a job aid. If recall must be very fast such as a train engineer knowing how to respond to a track signal, its meaning must be automated via drill and practice. However if recall does not need to be instantaneous, visual mnemonics are a proven memory device. Figure 11 on page 9 shows a graphic used to help recall the meaning of the Spanish word *Tenador*. Note that an effective mnemonic incorporates the meaning of the word (fork) with a familiar image that can readily be associated with the sound of the new word (ten and door).

Organizational graphics. Organizational graphics are extremely important to help orient learners to the structure and sequence of lesson content. An organizational graphic shows qualitative relationships among the main ideas in a lesson. Often geometric visuals are used as the basis for organizational graphics. For example, Figure 3 shown earlier is the organizational graphic I use to summarize the three factors that most influence the learning value of graphics. Visual organizers are commonly used in training materials and help avoid the disconcerting *blind trust walk*-like experience resulting from courses that provide no overviews of the content.

Relational graphics. Whereas organizational graphics display qualitative relationships, relational visuals communicate quantitative relationships among lesson content. Some common examples include bar graphs and pie charts. The use of relational visuals has exploded over the past 20 years. Luckily recent controlled research gives some good guidelines for best design and use of different types of relational graphics.

Transformational graphics. A transformational graphic is a visual that communicates movement through space or changes over time. These are commonly used in combination with representational graphics to illustrate procedures and processes. Figures 5 through 9 are all examples of transformational graphics.

Interpretive graphics. Interpretive visuals build understanding of concepts or principles that are abstract, invisible, or both. Figure 12 on page

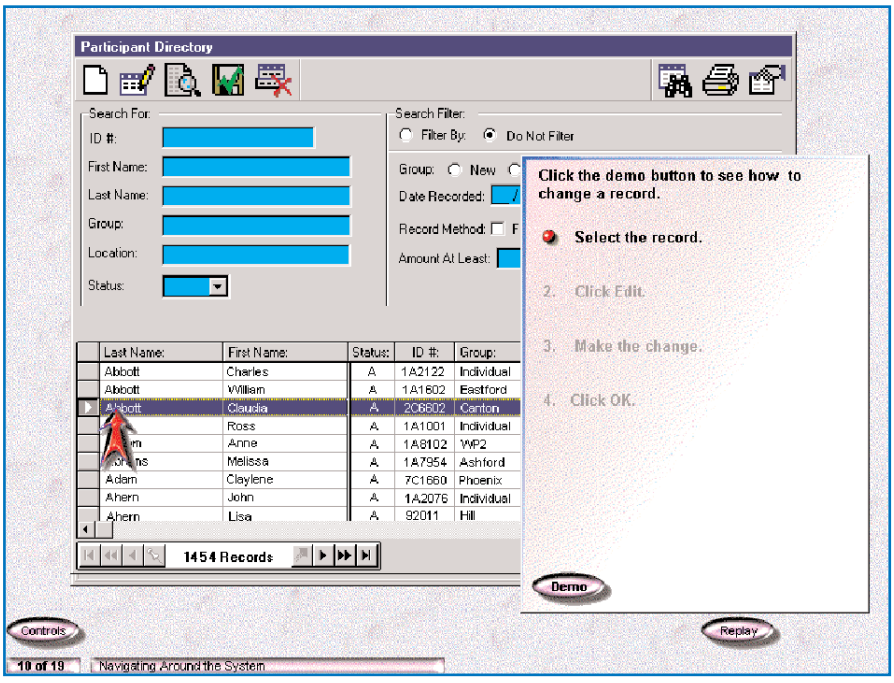

FIGURE 5 *A visual used to teach a systems application online*

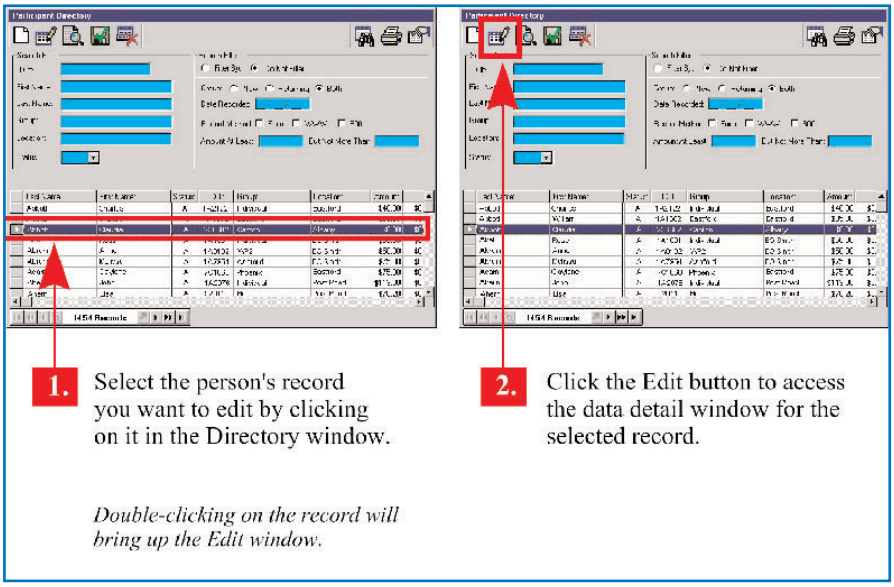

FIGURE 6 *The same visual adapted for display in print media*

9 shows an example developed by the Biologica project. Designed to teach secondary students the laws of genetics, the visual simulation allows students to change gene combinations on the chromosomes and immediately see the results in the dragon's features.

Interpretive visuals don't have to involve simulations or complex surface features. Gyselinck and Tardieu explained gas pressure laws using changes in the appearance of a closed paper bag corresponding with changes in altitude. They created three lesson versions. One used text alone, a second used text with simple representational visuals in the form of line drawings, and a third used the same line drawings but added arrows to convert the representational visual to an interpretive graphic. Both versions with graphics improved learning but the interpretive graphic resulted in the best conceptual understanding.

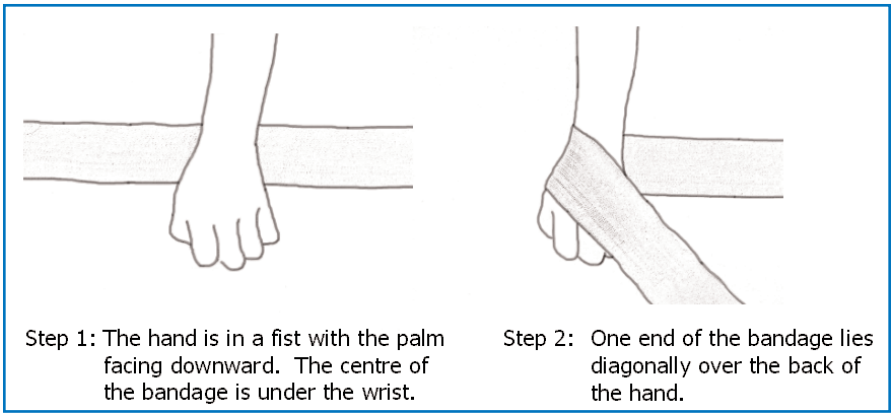

FIGURE 7 *Line drawing with text to show a bandaging procedure. (From Michas and Berry, 2000)*

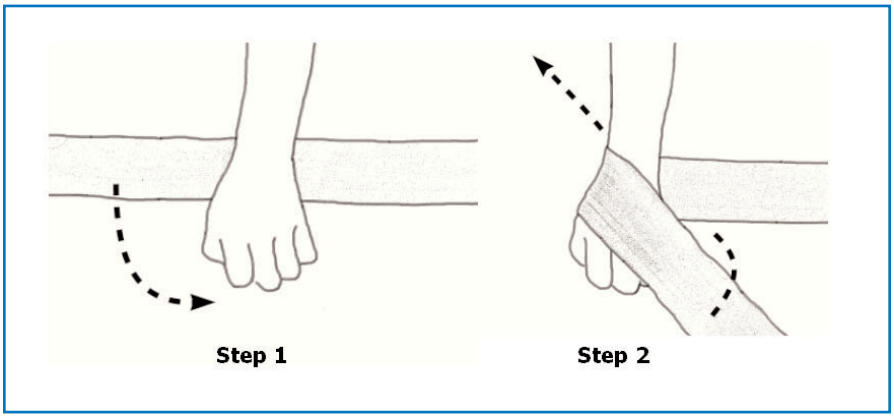

FIGURE 8 *Line drawing with arrows to show a bandaging procedure (From Michas and Berry, 2000)*

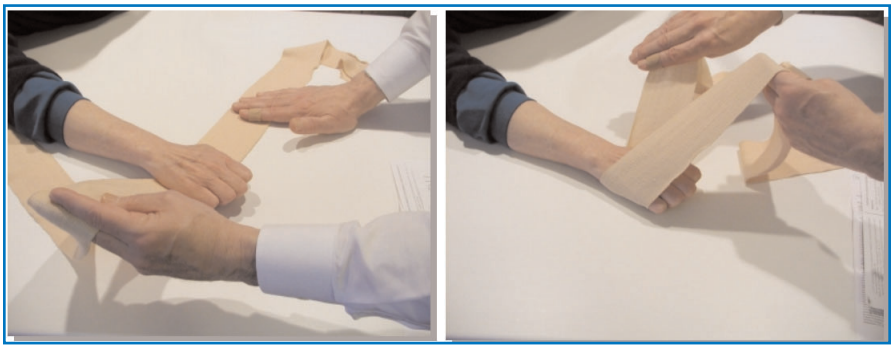

FIGURE 9 *Video animation to show a bandaging procedure. (Adapted From Michas and Berry, 2000)*

Which category of visual should you use?

As you can surmise from the communication functions of graphics, each category serves a different purpose and is best aligned with specific instructional content and goals. In general, procedural instructional goals are best served by a combination of representational and transformational visuals to demonstrate procedures and to contextualize online simulation practice. Facts benefit from representational visuals and, when there are multiple facts, from relational and organizational graphics as well. Concepts can be taught with representational visuals as well as interpretive and organizational graphics. Processes benefit from transformational and interpretive graphics. Principle-based tasks can make use of representational visuals to show the job context in which the tasks will be performed as well as organizational, relational, transformational, and interpretive visuals.

Planning your visuals systematically

As mentioned at the start of this article, the best graphic for learning purposes will depend on an interplay among your instructional goals, features of the graphic itself, and properties of the learning landscape including the training setting, the delivery media, and the learners who will participate. To derive the best graphic treatment you will need to apply a systematic visual design model. In Part 2 of this article, to appear in **The Journal** September 29, Chopeta Lyons will summarize our visual design model.

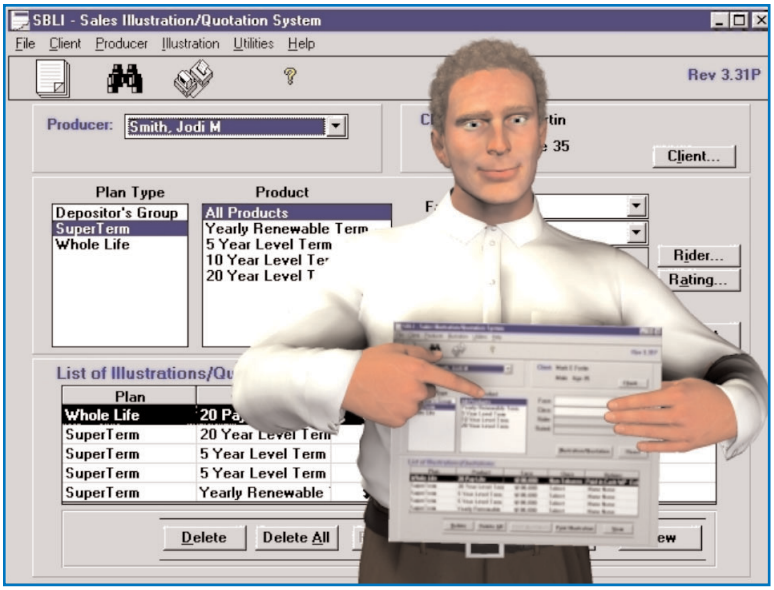

FIGURE 10 *A decorative visual in a systems course. (Credit: Mark A. Palmer)*

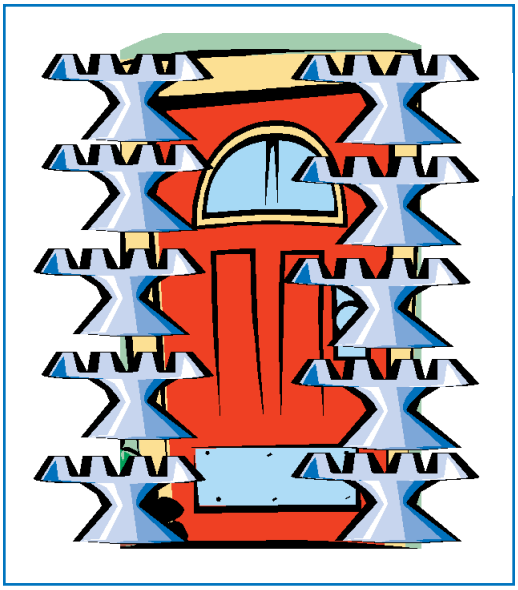

FIGURE 11 *A visual mnemonic for the meaning of the Spanish word: Tenador*

AUTHOR CONTACT

Dr. Ruth Clark is a recognized specialist in instructional design and technical training, and holds a doctorate in Educational Psychology and Instructional Technology from the University of Southern California. Prior to founding Clark Training & Consulting, she served as Training Manager for Southern California Edison. Dr. Clark is a past president of the ISPI. She is the author of three books including *Developing Technical Training*, the award-winning *Building Expertise*, and this year's *e-Learning & The Science of Instruction* (co-authored with Dr. Richard Mayer). Her next book, *Graphics for Learning: Proven guidelines for planning, designing, and evaluating visuals in training materials*, co-authored with Chopeta Lyons, will be published next spring.

Ruth and Chopeta will present a one-day workshop, "Processes and Principles to Visualize Your Instructional Message" on November 11, 2003 at *The Guild eLearning Producer Conference & Expo 2003* in San Francisco.

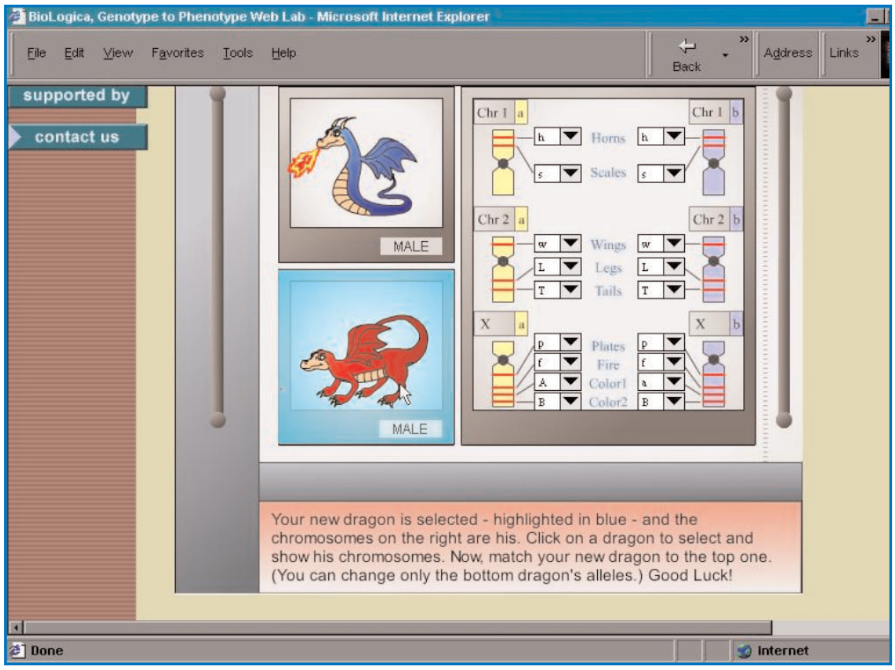

FIGURE 12 *An interpretive visual to teach genetics. (From the Biologica Project.)*

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