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THIS WEEK: Design Strategies

Learning Object-Based e-Learning: Content Design, Methods, and Tools

By Yonnie Chyung

Colleen is a freelance instructional designer. She recently talked with her client about the possibility of working on an exciting e-Learning development project. However, her client wants her to design it with learning objects, so that they can reuse them in other projects. She has years of experience in designing instruction for classroom training, and developing some online reference materials – but reusable learning objects? She has no experience in developing e-Learning programs with reusable learning objects, and she is not sure where to start. She wants this contract, so she is desperately looking for information. She keeps wondering: Which software should I use? Are there any "recipe" books or articles out there? Help!

Colleen visited my office a couple of weeks ago, looking for such information. She didn't have much time to learn all about e-Learning development. I wished I had a complete "recipe" book, made just for her project. I didn't. Many instructional designers may face a situation like Colleen's. Knowledge in traditional instructional design methods definitely helps them move into an e-Learning arena, but e-Learning design and development requires new sets

As an instructional designer, you may find yourself challenged to create e-Learning based on learning objects that support problem-based learning, and do so in a way that makes the content reusable. Do you know where to start? Do you have the right tools? Is the whole idea new to you? In this week's article, an expert walks you through everything you need to know to begin dealing with these challenges.

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of knowledge and skills. In this article, I intend to provide information that helps practitioners like Colleen make that transition.

Learning objects and reusable learning objects

What is a (reusable) learning object?

The term, learning objects, is a popular buzzword in the e-Learning field. One good source for a definition of a learning object (LO) is the Institute of Electrical and Electronics Engineers, which defines it as "any entity, digital or non-digital, which can be used, re-used or referenced during technology-supported learning" (see http://ltsc.ieee.org/wg12/). This definition explains what a LO is. But, what does a LO look like, and how is it constructed?

A common understanding is that a LO provides a small chunk of learning activity, built around *a single learning objective*. One benefit of utilizing LOs – a.k.a., reusable learning objects (RLOs) – in e-Learning projects is that you can *reuse* them when the same learning objectives are part of another learning situation, which increases cost-effectiveness.

However, learning objectives come in different shapes and sizes; thus, so do LOs. For example, compare the following learning objectives – (a) Define plastic deformation; (b) Given a hypothetical scenario, explain why the presented behavior is or is not workplace harassment; and (c) Among a list of banking accounts, recognize potentially fraudulent accounts.

A LO that teaches a simple concept such as plastic deformation may take less time than instruction on how to recognize workplace harassment. Also, while one can learn certain information along with other chunks of information in a cluster form, some tasks such as recognizing potentially fraudulent accounts may need to be learned through a series of instruction (or LOs), built upon job-related prerequisite knowledge. Therefore, before attempting to construct the overall structure of a RLO-based e-Learning course, it is essential for e-Learning practitioners to understand *content hierarchy* with different levels of LOs.

Content hierarchy

Autodesk, Inc. and Cisco Systems, Inc. are early adopters of RLO strategies (see Hodgins, 2002 and Cisco, 2003 in the References at the end of this article). Built upon Autodesk's content model, Cisco has developed its own e-Learning framework and authoring guidelines, describing the design of modular e-Learning contents in hierarchical format. One way to understand a hierarchical content structure of an e-Learning

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course is to think about how a textbook is usually organized. As shown in Figure 1, which is adapted from Cisco's framework, a textbook may contain several chapters, each chapter has several sections, and each section contains text that accompanies some photos or diagrams. Similarly, you can design an e-Learning course with several lessons, each lesson has several topics, and you can present each topic with multimedia such as text, images, animation, audio, and video clips.

Different levels of LOs

Conceptualization of the content hierarchy of an e-Learning course, as shown in Figure 1, also makes it easier to understand that there are different levels of LOs, such as course-level, lesson-level or topic-level LOs. Again, this is derived from the fact that there are multiple levels of learning objectives and a LO is built around a learning objective. When a *course* is defined as an entire instructional unit, a course-level objective is referred to as a terminal objective, and its enabling objectives derived from a series of *lessons* are known as subordinate objectives (Dick, Carey, and Carey, 2005). It is also possible to write a learning objective for each *topic* included in a lesson. For example, Figure 2 is a visual illustration of a simple content analysis, showing three levels of objectives; a course-level, a lesson-level, and a topic-level. Each box presented in the figure represents a LO; thus, there are course-level, lesson-level, and topic-level LOs. That is, e-Learning practitioners should be aware that when the term LOs is used, it may refer to different levels of LOs in the content hierarchy.

A lesson-level LO (RLO)

This *granularity* principle applied to e-Learning design, as illustrated in Figure 2, makes it possible to assemble and reassemble chunks of e-Learning content in different ways, as needed. In theory, LOs at any level may be reused; thus, making any level of LOs into *RLOs*. However, a commonly accepted practice is to refer to a *lesson-level LO* as a RLO. A formula for designing a lesson-level LO, based on Cisco's RLO strategy, is as follows:

Lesson = Overview + Several topics + Summary + Practice + Assessment

Practice questions are often included in the relevant topics:

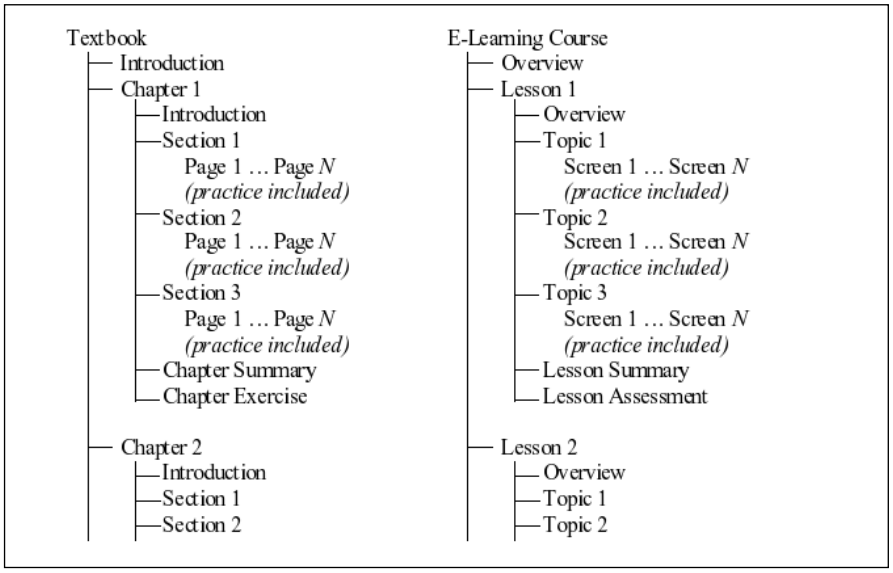
Lesson = Overview + Several topics w/practice + Summary + Assessment

Also, you can combine lesson-level assessment questions and present them in a course-level assessment at the end of the course. Then, an alternative formula for a lesson-level LO is as follows:

Lesson = Overview + Several topics w/practice + Summary

Cisco's guidelines refer to a set of an overview and a summary included in a lesson as a *wrapper*. The beginning part of a wrapper (the overview part) prepares learners to acquire new knowledge, and the ending part of a wrapper (the summary part) helps them reflect on the lesson they have just completed. In a way, designing an e-Learning lesson is similar to making a hamburger. A hamburger is served with a bun, sliced in half (i.e., a wrapper), and you choose what goes inside the bun based on what you want. Similarly, the main ingredients of an e-Learning lesson are a series of topics with practice, wrapped by an overview and a summary. You can assemble a different set of topics to design a lesson depending on the needs, just like you may make a single cheeseburger without onions for your child, while you make a dou-

Figure 1
The hierarchical content structure in a book and an e-Learning course.



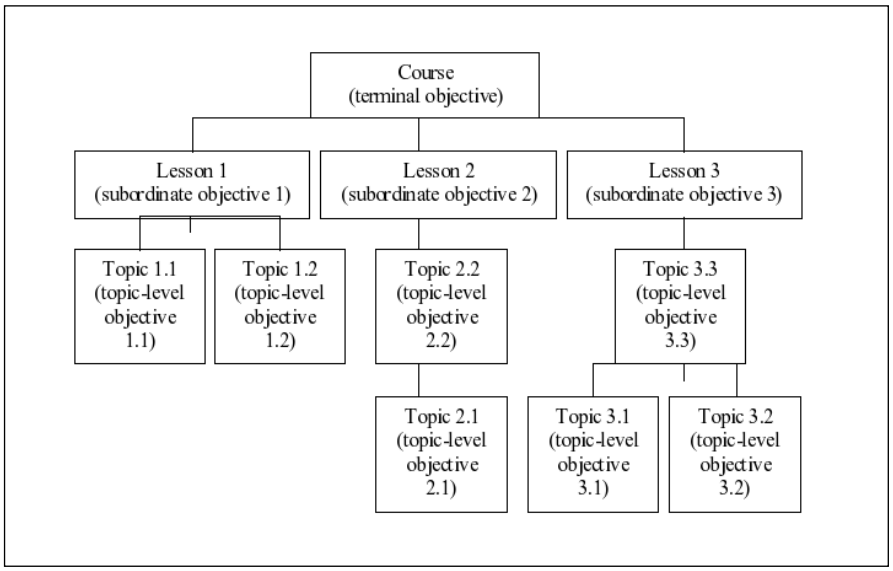


Figure 2 ***A simple content analysis.***

ble cheeseburger with a slice of tomato and onion for yourself.

Analyzing and designing LO content

One of the first things to do in e-Learning development is to conduct a content analysis. During a content analysis, you describe the overall content hierarchy of your e-Learning course with a series of lessons, and the content of required topics that make up each lesson. In doing so, you also need to apply appropriate *content taxonomy* and *instructional design models*. Instructional theorists have developed various content taxonomy models:

- Benjamin Bloom and his colleagues (1956) developed three domains of learning, including cognitive domain, affective domain, and psychomotor domain. The cognitive domain is the most popular one, and it includes six levels of learning: knowledge, comprehension, application, analysis, synthesis, and evaluation.
- Robert Gagné (1977) developed five domains of learning outcomes, including verbal information, intellectual skills, cognitive strategies, attitudes, and motor skills.
- David Merrill (1983) listed different types of content, including concepts, facts, procedures, and principles, in his two-dimensional performance-content matrix. Another dimension of the matrix is three levels of performance, including remember, use, and find. After an additional item, processes, has been added to the types of content, the five items are often referred to as CFP3 (Clark 1999), which Cisco uses in its RLO strategy (2003).

The purpose of analyzing instructional content using a taxonomy model is to determine the most appropriate methods and media to deliver the content. To be systematic, you should analyze the content before selecting methods and media. In e-Learning projects, the media category (i.e., computers) is already selected, but *media types* such as text, image, audio, video, and animation still remain as variables. Therefore, select appropriate media types to support the methods chosen to deliver the e-Learning content. Using a cooking analogy, you would decide whether to eat fish or pork first (the content), and then use different recipes (the methods), perhaps using different utensils (the media), to cook it.

Gagné described verbal information as declarative knowledge ("knowing what") and intellectual skills as procedural knowledge ("knowing how"). Building upon Gagné's idea, I propose a taxonomy of three categories for analyzing e-Learning content: 1. declarative knowledge ("knowing what"), 2. procedural knowledge ("knowing how"), and 3. situated knowledge

("knowing when and why"). This taxonomy is explainable within the framework of Merrill's two-dimensional performance content matrix. In e-Learning, the first two levels of performance, "remember" and "use," are emphasized (see Clark, 1999; Clark and Harrelson, 2002). Table 1 illustrates how the three categories relate to acquisition ("remember") and application ("use") of the five types of content. Declarative knowledge includes remembering and using concepts and facts. Procedural knowledge includes remembering and applying procedures and processes. Situated knowledge will often require all types, but an application of principles is especially important.

Declarative knowledge (knowing what)

Declarative knowledge is often a foundation for more complex knowledge. For designing this "knowing what" type of e-Learning content (concepts and facts), Gagné's nine events of instruction is useful. As shown in Table 2, the nine events align well with the overall lesson (RLO) structure, suggested in Cisco's guidelines.

For example, the previously-presented learning objective, *to define plastic deformation*, is a concept, and it is a topic-level objective. In an introductory materials engineering course, one usually learns this concept along with other related concepts and facts, such as elastic deformation, elastic region, and Hooke's law. They are the topics of a lesson titled, *Tensile Properties*. From the lesson, students not only acquire the new concepts and facts (the "remember" level), but also solve problems by using the concepts and facts (the "use" level). You can reuse this lesson in an advanced engineering course; thus making it an RLO. When developing this type of e-Learning content, you often need software that allows you to easily present visual representations to illustrate abstract concepts and facts, such as diagrams, images, animation, and video clips.

Procedural knowledge (knowing how)

The "knowing how" type of content includes *procedures* and *processes*. To differentiate procedures from processes, think about a medical *procedure* that a doctor would follow during a surgery; it's a step-by-step procedure, usually done by one person. Compare it to a manufacturing *process*, which is often a flow of interrelated steps, involving many people.

One can apply Gagné's nine events of instruction to the design of a *process* type of e-Learning content. If the content consists of *technical procedures*, an alternative method is a show-tell-do-check method, which is an on-the-job training method, originally developed during World Wars I and II. Table 3 shows how the show-tell-do-check method aligns with Cisco's lesson structure.

For example, suppose you are designing a lesson with several procedural topics such as how to send a meeting request using a groupware system. In this lesson, you would first provide a demonstration of the procedure to be learned – this is a "show and tell me how to do it" step, or the "remember" level. After learners become familiar with the procedure, you ask them to actually try it, and provide them with guidance when needed – this is a "let me try it" step. At the end, you ask learners to perform the task without receiving any help – this is a "test me" step. These are the "use" level of performance. When developing this type of demonstration and simulation e-Learning

Table 1: *Content Taxonomy Models for e-Learning development*

Three categories of e-Learning content	**Type: CFP3 Level: Remember ⟶ Use**
Declarative (knowing what)	Concepts and facts
Procedural (knowing how)	Procedure and processes
Situated (knowing when and how)	Principles

Table 2: *Gagné's Nine Events of Instruction applied to an RLO*

RLO structure	**Gagné's nine events of instruction**
Overview	1. Gain attention 2. Inform learners of objective 3. Stimulate recall of prior knowledge
A series of topics with practice to help learners *remember* and *use:* • Concepts • Facts	Repeat a sequence of the following four events per topic: 4. Present new content 5. Provide learning guidance 6. Elicit performance 7. Provide feedback
Assessment	8. Assess performance
Summary	9. Enhance retention and transfer

Table 3: *The Show-Tell-Do-Check method applied to an RLO*

RLO structure	**The show-tell-do-check method**
Overview	Introduction
A series of topics with practice to help learners *remember* and *use:* • Procedures (technical)	Repeat a sequence of the following two events per topic: 1. *Show* and *tell* me (demonstration) 2. Let me *do* it (simulation)
Assessment	*Check* (test) me (simulation)
Summary	Summary

content, you need software that has screen capturing and editing capabilities.

Situated knowledge (knowing when and why)

E-Learning programs can teach not only what it is and how to do it, but also when and why to use certain information. Situated cognition (knowing when and why) requires acquisition and application of *principles*, often built upon relevant declarative and procedural knowledge. An instructional method that helps develop situated cognition is a problem-based learning (PBL) strategy. In a face-to-face group learning environment, group discussions and collaboration with peers facilitates PBL. But, in a self-paced e-Learning environment, interaction occurs between the learner and the content without the presence of peers. Therefore, it becomes critical to design a self-paced e-Learning lesson with a sophisticated inquiry-based navigation sequence and constructive feedback, which can be a challenging task.

A simulated role-playing technique is often utilized when implementing the PBL method in e-Learning (see Table 4). Learners are presented with a problem using a realistic scenario, and then they are guided through the process of selecting the most appropriate actions to solve the problem. In doing so, learners often participate in simulated role-playing, and are encouraged to use resources provided in the program. They receive constructive feedback on their actions, which helps them understand the consequences of their actions. You can also use the simulated role-playing technique in the lesson assessment.

For example, when workplace harassment-prevention training is delivered to employees, its goal is to help them not only understand harassment policies and guidelines (the "remember" level), but also be able to prevent, or to recognize and report, harassment situations (the "use" level). When developing this type of e-Learning content, you may want to look for software that allows you to branch through multiple paths of actions and provide immediate constructive feedback. Also, to create a more realistic context, you want to increase the degree of fidelity by using

Table 4: *The Problem-Based Learning method applied to an RLO*

RLO structure	The problem-based learning method
Overview	Introduction
A series of topics with practice to help learners *remember* and *use:* • Principles	Repeat a cycle of PBL within a realistic scenario: Role-play within a realistic scenario Present a problem Provide feedback Provide resources Elicit a solution (action)
Assessment	Assessment
Summary	Summary

animation and video clips of actors playing out situations, rather than still images or text only.

Selecting LO development tools

When you are ready to develop your e-Learning course, you may wonder which LO development software you should use. There are a variety of tools on the market. Among those, I will discuss Articulate® Studio (including Presenter™ and Quizmaker™), TechSmith®'s Camtasia Studio™ and Adobe® Captivate™, based on my experience as an end-user. I have no affiliation with any of the corporations.

Although it is possible to use any one of these tools to develop different types of content (as shown in Table 5), each one has its unique features that make it more useful than others, depending on the LO content and the method you have chosen. For example, if you are developing instruction to teach mostly declarative knowledge, you will be able to use any one of the three tools, but you may find Articulate particularly helpful. It is easy to learn to use, and Quizmaker provides a variety of features for constructing test questions. If you are developing technical demonstrations ("show and tell") and simulations ("let me do it" and "test me"), you will find Camtasia or Captivate quite useful. To quickly develop a series of branching sequences in your lesson, Captivate's branching feature will come in handy.

Table 6 (at the end of this article) provides a summary of selected features of each tool. I reviewed the most recent version of each tool at the time of writing. Since describing the selected features of each tool in detail is beyond the scope of this article, I will discuss the following three features: (a) feedback provided in knowledge testing, (b) demonstration and simulation of technical skills, and (c) branching for soft skills.

Feedback provided in knowledge testing

When testing knowledge during practice or in an assessment at the end of a lesson, you can provide different types of feedback:

1. No feedback – A learner completes a series of questions without receiving any feedback.
2. Answer-specific feedback – When a learner submits an answer to a question, provide feedback specific to the chosen answer.
3. Question-level feedback – When a learner submits an answer to a question, provide generic feedback on that question.
4. Test-level feedback – After a learner completes a test, present a summary report of the test results. The report may include the test score, a review of chosen answers, feedback on the answers, and a pass or fail result.

All three tools discussed in this article can provide each of the different types of feedback in slightly different ways. But, compared to Camtasia's quiz function, Articulate Quizmaker and Captivate provide more options to choose from, such as inserting an image on a question screen, enabling quiz review, shuffling answers, and randomizing and pooling questions from a question bank. Therefore, it is helpful to check whether or not it is critical to use these options in your e-Learning project before choosing a tool.

Demonstration and simulation of technical skills

Camtasia and Captivate provide features that allow you to easily capture screen movement and to develop demonstration and simulation types of e-Learning content to use for technical skills training. For example, to demonstrate how to use a new learning management system, use either Camtasia Recorder or Captivate's software simulation option to capture screens with cursor movement and sound effects. One thing that you want to keep in mind is the types of video output files that these two tools produce, especially if it is important to produce a consistent type of media files to make them readily reusable in other projects. Captivate produces *swf* files. Camtasia Recorder produces *camrec* files, but you can import them into Camtasia Studio and then produce other types of video output files, including swf files. You can use this feature in Camtasia as a file converter.

You can use both Camtasia and Captivate to develop a simulation type of e-Learning content. With Camtasia, you can add a transparent *Callout with a Flash Hot Spot* to make your clip interactive – for example, you can have learners click on a certain spot on the screen in order to proceed. Captivate has a more sophisticated built-in function that allows you to easily record and produce training (practice) simulation and assessment simulation files. Also, you can store data obtained from a "test me" type of Capti-

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Table 5: *Matching e-Learning content, design methods, and development tools*

Content Domain	Declarative knowledge (knowing what)	Procedural knowledge (knowing how)	Situated knowledge (knowing when/why)
Content Type	Concepts and facts	Procedures (technical)	Principles
Design Method	Nine events of instruction	Show-tell-do-check	Problem-based learning
Development Tool	Articulate * Camtasia * Captivate *	Articulate Camtasia * Captivate *	Articulate Camtasia Captivate *

Note: The asterisk above (*) indicates that the tool has unique and potentially useful features for developing the specific type of content, as discussed in this article. It is not an indicator for the overall quality of the tools.

vate simulation on your learning management system, which is not available in Camtasia's *Callout with a Flash Hot Spot* function. However, Camtasia provides simple but useful video editing features and you can use it as a video editor; you can import video clips, and then easily cut or split portions of the clips, add clips together, remove audio, or show picture-in-picture. Articulate does not have such built-in features for screen capture and editing, but instead, you may present a step-by-step procedure with images, import Flash video files, or insert Web URLs into PowerPoint slides.

Branching for soft skills

It is possible to make a branching menu with all three tools. With Articulate, you can create menu items with hyperlinks that open specific slides, and with Camtasia, you can add a transparent *Callout with a Flash Hot Spot* to each menu item, and set each one to jump to a certain frame. But, Captivate's built-in branching capability can make the task much easier. This branching feature supports the use of a PBL method to teach ill-defined soft skills. Although you can view it as a series of questions and answers at a glance, the important key lies in the development of systematic branching with constructive feedback in each step that helps learners reflect on their choice of action and develop cumulative learning.

For example, let's say that Colleen, whom I introduced to you in the opening story, was tasked with converting existing classroom training materials on workplace discrimination to an e-Learning course. She was provided with the existing print materials, and other resources such as the U.S. Equal Employment Opportunity Commission (EEOC) Website (www.eeoc.gov/types/). Now, she has to conduct a detailed content analysis in order to determine the type(s) of content to deliver, and she needs to select effective instructional methods and media types to design the course. She can better answer a question as to which software she should use when she has this big picture of the overall parameters of the project. A course on workplace discrimination likely requires acquisition and application of a set of principles (e.g., what constitutes discrimination, and why?), as well as related concepts (e.g., who are "covered individuals?"), facts (e.g., "In Fiscal Year 2006, EEOC received 13,569 charges of age discrimination.") and processes (e.g., steps to follow when filing a discrimination-related complaint).

As indicated in Table 5, she may use any one of the three software programs to develop this e-Learning course. However, if Colleen intends to implement a PBL strategy in the lessons, she may want to consider using Captivate to develop a scenario-based

Table 6: *Selected features of LO development tools*

Tool	Articulate Studio 2 Standard	Camtasia Studio 4	Captivate 3
[1] Price per copy	$1347.00 (check for special price)	$299.00	$699.00
[2] Audio Features	Record Narrator, Import Audio, Timeline Audio Editor	Timeline (fade in/out, volume up/down, replace with silence, audio enhancements)	Record, Import, Edit Timing (cut, insert silence, and adjust volume)
[3] Video (Slide/Frame) Features	No (PowerPoint is the platform)	Import media, Zoom-n-Pan, Clip Speed (%), Picture-in-Picture	Text caption, text animation, multimedia, interactive buttons, etc.
[4] Multimedia Elements that Can be Included	Image – emf, wmf, jpg, png, bmp, gif, tiff, eps, etc. Audio – mp3, wav Video – swf PPT custom animation Web object – URL	Image – bmp, gif, jpg, png Audio – wav, mp3, wma Video – camec, avi, mpg, mpeg, wmv (Note: No swf import)	Image – bmp, gif, jpg, png, ico, emf, wmf, pot Audio – wav, mp3 Video – swf., gif, avi, fla, flv
[5] Screen Capture and Edit Function 1. "show/tell me" 2. "let me try" 3. "test me"	No	Yes – 1 and 2 Captured file – *.camrec Produce video as swf/flv, wmv, mov, avi, IPod/Tunes, mp3, rm, camv, gif animation	Yes – 1, 2, and 3 Video output file – *.swf
[6] Interactive Features 1. Navigation control 2. Interactive content	1. Timed presentation using Timeline Audio Editor 2. Learning Games (Choices, Word Quiz and Sequence)	1. Timed presentation using Timeline or Storyboard 2. Callouts	1. Timed presentation using Storyboard, Edit, or Branching 2. Rollover Caption, Rollover Image, Rollover Slidelet, Zoom Area, Text Entry Box, Click Box, Button
[7] Quiz/Survey Questions (Basic: Multiple choice, T/F, fill-in-blank, and short answer)	Quizmaker = Basic + multiple response, word bank, matching or sequence drag-and-drop, matching or sequence drop-down, numeric, hotspot. Also provides survey options.	Quiz and Survey = Basic Note: No images can be inserted	Question Slide = Basic + matching, hot spot, sequence, rating scale (Likert)
[8] Quiz Feedback 1. No feedback 2. Answer-level 3. Question-level 4. Test-level	All optional Other features: Shuffle answers, Pool and randomize questions, Timed-test, Enable quiz review, Allow printout results	All optional (a test-level summary is delivered via e-mail)	All optional Other features: Enable quiz review, Random Question Slide, Question Pools Manager, Import Question Pools
[9] SCORM and AICC	SCORM 1.2 and 2004, AICC	SCORM 1.2 and SCORM 2004	SCORM 1.2 and 2004, AICC
[10] Section 508 Features	Notes (caption)	Caption	Slide text, notes, closed caption

environment with a role-playing technique.

For example, in the scenario, an employee (which is the role that the learner is playing) is told by her employer that the she would not be able to receive service credit for the time she took off during her maternity leaves (adopted from http://www.eeoc.gov/ policy/docs/benefits.html). She is surprised, and does not know what to say immediately. To help her understand the situation better, you can provide links to additional resources; for example, explanations about what constitutes discrimination, information about the Pregnancy Discrimination Act, and records of treatments that other employees in the company received during their non-pregnancy-related medical leaves. Then, you can prompt the employee with a question with several options, asking what she should do. She receives immediate constructive feedback on her action. And, she continues with the next step of simulated role-playing.

What's next?

The previous sections provided an overview of LO-based e-Learning content design and an introduction of several LO development tools. Before starting a new e-Learning development project, it is helpful to review sample e-Learning programs that your colleagues recommend or demo programs available on the Web, and to try several tools such as the ones introduced here. Most vendors provide a free trial version for a limited time. Online documents and video tutorials are also available on their Websites. For example,

Articulate Quizmaker:

- www.articulate.com/products/demos/quizmaker/getting-started/
- www.articulate.com/support/help/quizmaker/v2/

Camtasia (video tutorials):

- video.techsmith.com/camtasia/latest/edu/showme/enu/cs_showme.html
- video.techsmith.com/camtasia/latest/edu/howto/enu/howto_cs4.html

Captivate:

- www.adobe.com/devnet/captivate/
- Also, "Getting Started Tutorials" videos come with the software.

But, always remember that a good product comes from a good design. Donald Norman's advice (1988) on the design of everyday things applies here: "The choice of software should not be used as an excuse for poor design."

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