The e-Learning Design Challenge
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For or against?

The promise of e-Learning generates as much criticism as applause. This is not because e-Learning lacks the potential to dramatically change the way teachers teach or learners learn, but because the design and implementation of e-Learning applications remains in its formative years.

Resistance is futile.

E-Learning affords a lot of opportunities. In one hand, enhancing classrooms with computer-aided instruction offers innovative ways of delivering information and stimulates collaborative learning. In other hand, e-Learning provides an economic advantage for higher education: less costs and more value in running a class (Twigg, 2002).

Cutting corners.

Sometimes the attitude toward cost-effectiveness has resulted in building cheaper, less effective e-Learning courses. Information is expensive to produce, but cheap to reproduce (Shapiro and Varian). But e-Learning courseware is not just about content, but the delivery of that content.

Be effective.

As e-Learning continues to evolve, it is important to remember how people learn. Developers must consider and understand instructional design and its integration into building e-Learning courses. The quality and value of e-Learning applications is also dependent on:

1. The use of available technology
2. The design and development of applications.

In the next sections, we will explore what developers need to know about design and technology for e-Learning solutions:

1. E-Learning functional philosophy

There are several key concepts in developing E-Learning courses and applications. These concepts not only distinguish web-based learning from traditional classroom environments, but also demonstrate its strength as a scalable and distributive network technology.

Standardization

An increasingly popular idea in networked industries is the idea of setting standards to encourage universal recognition and distribution among competing developers. If an industry can agree upon standards in the language and components of software design, it fosters interoperability between systems and applications. In this way, developers and educators can interconnect content and tools from different vendors.

Successful Standards: HTML, XHTML and XML

The most ubiquitous and accepted standards involve the language of building web sites. The World Wide Web Consortium (W3C) continues to evolve the Web development language from HTML, which is universally interpreted by all web browsers, toward XHTML and XML, markup languages that allow more flexibility in tag creation for style and content management, as well as the ability to modularize and extend traditional HTML content.

Standards Organizations

There are several organizations that are leading development in setting standards for E-Learning. The key groups are listed below with a brief summary and links to their web sites (Rosenberg, 2001:169):

Airline Industry CBT Committee (AICC)
Although this organization focuses on developing guidelines for the aviation industry for delivering Computer-Based Training, its efforts to promote interoperability are widely successful.

EDUCAUSE Instructional Management Systems Project (IMS)
More and more vendors are following the guidelines set for by the IMS, which define open specifications for using educational content, tracking learner performance, and maintaining administration and record-keeping.

IEEE Learning Technology Standards Committee (IEEE LTSC)
This organization certifies and accredits contributions from other organizations to publish official industry technical standards, recommendations and guidelines.

Challenges in Standardization

Of course achieving interoperability does not occur quickly. Although advances are increasing the use of standards, industry awareness is still a

concern (Rosenberg,2001:170). If more buyers become aware of the need to use standardized software and hardware, then vendors will be encouraged to conform to standards practice, rather than build proprietary systems in hopes of market lock-in.

Perhaps a larger concern for standards integration involves an infrastructure needing an overhaul in order to interconnect with newer systems. The legacy systems that were implemented before Internet-architecture dominated may not be compatible with new software, or inexpensive to replace or modify.

Modularization

Another exciting achievement in software and web development involves breaking down content and language into reusable parts. At first this was thought of as a successful model for rapid development – now it is understood as a powerful way to manage and repackage information.

Information Objects

Granularizing information by breaking it down into discrete units allows another level of interoperability. Independent, self-contained modules make lessons self-sufficient (Horton, 2001:174), and provide the ability to assemble courses from a series of reusable components, making E-Learning solutions easy to design and cost-effective.

Component Parts

Creating discrete units involves the identification of the component parts of a course. This includes text objects that highlight specific concepts or media that reinforce or demonstrate particular topics.

Sharing Objects

Once information objects have been defined, object libraries can be created. Educators and developers can choose from a library to create customized, highly scalable sequences for various E-Learning applications. The benefits are manifold: lowered costs through recycling; personalized content based on learner-needs and flexible design that can be reconfigured quickly (Rosenberg, 2001:171).

Modularization redefines the relationship of information and knowledge and the linear construction of content developers are used. Eric Parks, Ph.D., President and CEO of ASK International calls this a "new language of learning." Click here to learn about this language.

Scalability

Although the idea of scalability remains inherent in most networked industries, scalability does not just involve a flexible infrastructure. For E-

Learning, scalable *content* is equally important. The previous notions of standardization and modularization leads to scalability, and certainly most E-Learning packages could reach 100 or 100,000 participants similarly, but as the rising need for understanding education in a global context becomes paramount, redefining scalability in terms of content is the next step.

Product Portability
All applications must remain complete flexible to a new product line and transition effortlessly into new technology infrastructures. In one case, this involves underdetermined design; that is, design that meets the requirements of the lowest common denominator.

Market Entry
Fitting into a new market involves more than product portability, it also involves strategically assessing how E-Learning fits into global domains and leveraging government support with commercial partnerships (Eduventures, 2001).

Language Barriers
Another level of creating knowledge objects is making them scalable to multiple languages. Although proper translation of material, as well as using standardized knowledge for math and science concepts (ex. meter vs. foot, or celsius vs. farenheit) is essential, preparing discrete units so content can be easily changed might be one of the most difficult challenges for the developer.

Synchronous v. Asynchronous Technologies

A very important design decision regarding E-Learning applications involves whether the content should be synchronous or asynchronous, or more importantly, how to blend the two (Horton, 2001:55).

Synchronous Examples
Synchronous technologies involve real-time ritualistic communication. All participants are responsible to perform activities at the same time. Examples include instant messaging or chat rooms, audio/video conferencing or white board sessions.

Asynchronous Examples
Asynchronous technologies follow the "anytime-anywhere" model of E-Learning more closely, and allow a self-paced approach. These typically include multimedia presentations, message boards, web pages or online quizzes. The learner can access the information whenever needed.

Hybrids
Each model has benefits and challenges. While synchronous models encourage the social side of learning and create less isolated learning spaces,

they demand that all learners work at the same pace, and remove some of the time/space freedoms E-Learning is so often associated with. Perhaps most importantly, however, synchronous models are more costly and require more technology: higher network speed, such as broadband; and more complex apparatus such as web cams.

Synchronous models allow the student to enjoy self-paced study, repetition and more personalized content, but can create the feeling of remoteness. What the developer should keep in mind is that the hybrid of these two models creates exciting possibilities for E-Learning. By defining which components of a course should be delivered as knowledge objects and which components should foster social learning remains imperative.

CASE STUDIES

MIT OpenCourseWare
Open sourcing the curriculum of popular classes, MIT pioneers a new way to deliver E-Learning without brand dilution.

http://ocw.mit.edu/index.html

Macromedia dives into e-Learning
Macromedia **Extreme** combines Flash with modularized components to allow customizable E-Learning applications that are learner-driven. Choose from synchronous and asynchronous models.

http://www.macromedia.com/desdev/contribute/extreme/extreme001.html

Macromedia **Contribute** allows all students and faculty with no web building experience to build collaborative web sites.

http://www.macromedia.com/resources/education/special/contribute/hed.html

Columbia University's Use of Live Experts
Columbia University offers live webcasts from distinguished lecturers, professionals or experts from various fields.

http://www.ccnmtl.columbia.edu/

2. Models of e-Learning

After assessing the goals of a course, the material that will be used and the methods of evaluation, the developer can choose between three distinct models of E-Learning. These can be used stand-alone or as hybrids to provide a diverse learning experience. They include:

1. Presentation Model
2. Interactive Model
3. Collaborative Model

Presentation Model

In this asynchronous model, information is presented one-way to the learner via text, graphics and sound. It is a demonstration, a simulation, a story or a movie.

Watching television or going to movies is a favorite activity for Americans, so the presentation model should be quite effective, as this is the medium people are used to. Using production techniques that capture the learner's attention is the key to making effective presentations.

The obvious advantage for using Presentation models is the lack of individual hardware requirements to deliver the information to a large audience, but critics might argue presentation models are not as engaging as the other models.

Interactive Model

The interactive model takes presentation of materials a step further by requiring users to interact directly with the material. This can be as simple as clicking buttons to navigate themselves through the course content or more involved such as answering test questions, running experiments, or connecting objects and concepts. A biology class, for example, might have a learner use the mouse to build an endocrine systems in a blank human body. A chemistry class might have the learner experiment with mixing chemicals with polymers in a simulated environment.

This model might have more impact on learning, as learners become directly involved in material. Learners make active choices, navigating their own path and understanding the building blocks of their studies. The new science of learning, as presented by the National Research Council, states the most important aspects of learning and knowledge, involve **active learning**, where learners control their own learning, **metacognition**, where learners are monitor their mastery of skills, and **transfer of learning**, where learners reuse previously learned material in new arenas (**National Research Council, 2000**). The interactive model of E-Learning supports each of these notions.

Collaboration Model

The collaboration model encourages the social aspect of learning, as it creates online communities which share information and discourse, or complete collaborative work and projects.

Message boards, for instance, foster an archived knowledge base of a community of practice. It allows multiple topics with threads that can be collapsible or expandable, demonstrating an easy way to organize the discourse.

Document repositories allow a central database to store and organize documents, offering excellent accessibility to course materials, or for peers to file-share when working on a collaborative project.

A more synchronous example might be the web-based video conference, where multiple participants from various geographical locations use real-time audio/video transmissions to have class or foster discussion.

Even email can be effective in allowing the discourse to continue anytime-anywhere. Professors become more available and peers have an easy, non-intrusive way to contact each other and promote the completion of the project.

Case Studies:

ExploreMath.com

ExploreMath uses unique multimedia applications for educators to introduce mathematical concepts in classroom settings. Each concept is an interactive simulation or puzzle to accompany a lesson plan.

http://www.exploremath.com/activities/index.cfm

Humans in the Natural World

An E-Learning zoology course at the University of Guelph. This application won the NaWeb 2001 award for best single course.

http://www3.open.uoguelph.ca/de/ideaExchange/zoo1500/

MIT Media Lab: The Future of Learning Group
Project: Re-thinking Mentor Development

"This project proposes the use of educational technologies that have the following characteristics: they not only allow, but also encourage people to produce (vs. consume) information and content; they invite people to collaborate and communicate with others who share the same interests,

goals and needs; they are functionally or conceptually transparent (vs. opaque) because they allow deeper level of understanding; and finally, they allow reflection."

http://learning.media.mit.edu/projects.html

3. Design Tips for E-Learning

Designing E-Learning applications involves several components:

1. Designing the user interface and multimedia to suit learner needs and maximize the learning experience.
2. Constructing content which is personalized and effective.
3. Structuring the system to allow continuous evaluation from and for the learner.
4. Incorporating innovative ways to manage and explore large and complex amounts of information.

In the following sections, we will explore some basic principles in the above categories and list some simple design guidelines for building E-Learning applications.

Interface Design

The "medium is the message" is one of the distinct realizations of contemporary media studies. As our mediums continue to evolve and converge, the interface remains the crossing point. Some of the basic principles of metaphor and iconic representation developed by pioneers in human-computer interface design such as Xerox PARC or the Apple Computer Group still dominate the inputs and outputs of digital technologies. For purposes of E-Learning applications, understanding how to build these interfaces and representations is essential.

The Lowest Common Denominator

Although computer hardware and software gets faster and cheaper, a digital divide permeates all development. The platforms, networks and bandwidth varies with each institution and individual. When understood in a global context, even the training and understanding of using technology contrasts between countries.

By designing each application to the lowest common denominator, one that supports various platforms and bandwidth issues, the E-Learning application becomes more usable and accessible. However, much of the excitement surrounding E-Learning involves intense graphics or sound, and "dumbing" down the design could prove to be a constraint. Delivery methods such as Macromedia Flash are examples of how complex graphics and animation can be delivered via Internet with bandwidth in mind, producing high-level

content and interactivity with small file sizes and complete browser compatibility.

Another aspect of designing for the lowest common denominator is simplifying the design elements and removing any information and iconic "clutter" on an interface. As Theodor Holm Nelson, a Distinguished Fellow for Autodesk, Inc. states, "The relationship between *power and flexibility for the user* and *simplicity at the interface* need not be inverse…the best software design assimilates all its functions to a few clear and simple principles" (Nelson, 2001).

Menus as Advance Organizers
In order for the learner to conceptualize an E-Learning application's structure and functionality, the interface menu is typically the map. This map allows the user to understand the domain (Nicol, 1999). The developer, or map-maker must carefully organize and group menu items according to what tools, objects or actions are required, as well as incorporate traditional menu items such as File or Edit.

Use of Multimedia
Finding the right blend of text, graphics and sound can mean the difference between E-Learning success or failure. Combining graphics and sound create engaging environments, while real-time simulations provide real-world applications for students.

Words and graphics in combination are more effective than words alone. Action and graphics serve as production techniques that not only emphasize a point, but also capture the attention of the learner (Doolittle, 2002).

Narration in combination with text words work better than words alone (The E-Learning Developers Journal, 2002: 4). The repetition helps the learner to retain information better. In effect, repeating similar content through a variety of media engages the attention and motivation of the learner.

Personalizing content

myLearningExperience
The first way for software to engage a learner is to recognize their name. Storing user profiles and allowing customizable components, including style and color schemes is essential to making the learner embrace the technology.

The learner should also be able to customize the front page of the application to provide quick links to the tools she uses most, or news and information she finds most important. This is another level of modularizing components so the structure remains accommodating and adaptable.

The Tone of the Writing

The tone and voice has a significant impact on the way learners respond to and retain information in E-Learning scenarios. Conversational tone removes resistance to technology and often leads to more comfortable environments and better information retention (The E-Learning Developers Journal, 2002:7).

Continuous Evaluation

Feedback Loops

In all stages of the learning process, E-Learning packages should generate feedback to test progress and allow the learner to monitor their mastery of skills or information. This occurs by featuring quizzes and permitting areas to practice. Navigation that allows a learner to move to new material or previous material also encourages a sense of efficacy that enriches the experience.

Testing the Market of Learners

The only way to improve E-Learning design is to build a flexible structure and incorporate continuous feedback from learners. From an apparatus perspective, creating user interfaces that are intuitive often occur when the leaner asks "What does that tool do?" or states "You need a way to click here…"

By getting feedback in the initial stages of design, better E-Learning packages are built. After each successful course, getting feedback results in constant improvement of the system.

Knowledge Management

Knowledge that resides in people is not as effective as knowledge that resides in organizations. In education, this not only allows an institutional history, but a more efficient work flow and sets of tools that make learning more effective.

Tacit and Explicit Knowledge

Explicit knowledge, such as the textbook, syllabus or class notes can be easily captured and retrieved. But tacit knowledge, such as the skills developed in the classroom, the enhancements and experience a professor has added to the curriculum or the milestones of solving a problem prove to be one of the biggest challenges in imparting knowledge. Knowledge management has a unique model for handling both tacit and explicit knowledge: the ability to share and create knowledge as a group, archive that knowledge, and provide an easy space for future learners to retrieve it.

Models of Knowledge Management
Knowledge is often considered in three levels (Rosenberg, 2001:70):

1. **Document repository**
   The first efforts of knowledge management involve the ability to store and manage documents in a central location.

2. **Information creation and sharing**
   As people create and contribute information, the knowledge database continues to expand. Correctly organized, it becomes faster to find information online than to sift through books. The information can be continually updated so it's always contemporary.

3. **Enterprise intelligence**
   The highest level of Knowledge Management occurs when a highly complex and robust database of knowledge is organized and accessible to learners, increasing system performance through the use of proper tools (i.e. "help" features, wizards, design templates), exceptional search engines and collaboration components which allow seamless communication.

Case Studies

Google.com
An advanced search system that ranks pages by their "importance", linguistic relevance and incorporates a unique math algorithm.

Autonomy.com
This company implements knowledge management for enterprise level company with sophisticated math principles to capture a documents "essence" and intelligently manage documents across different software packages and platforms.

ABOUT THE AUTHOR
David Huffaker's interests surround education and technology, exploring betters way to build learning tools and to implement technology in K-12 and Higher Education. He is a Master's Candidate in the Communication, Culture and Technology program at Georgetown University, and a graduate research assistant at the Children's Digital

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WORKS CITED

National Research Council. (2000) How People Learn: Brain, Mind, Experience, and School. John D. Bransford, Ann L. Brown, and Rodney R. Cocking (Eds.) Washington D.C.: National Academy Press.

Doolittle, Peter. (2002) "Multimedia Learning: Empirical Results and Practical Applications." White Paper.

Eduventures (2001) "A Global Education Market?" Corporate White Paper.

Hanna, Donald E., Michelle Glowacki-Dudka, and Simone Conceicao-Runlee. (2001) 147 Practical Tips for Teaching Online Groups : Essentials of Web-Based Education.

Horton, William K. (2001) Designing Web-Based Training: How to Teach Anyone Anything Anywhere Anytime.

Nicol, Anne. (1999) "Interfaces for Learning: What Do Good Teachers Know That We Don't?" The Art of Human-Computer Interface Design. Laurel, Brenda (Ed.)

Nelson, Theodor Holm. (2001) "The Right Way to Think About Software Design." The Art of Human-Computer Interface Design. Laurel, Brenda (Ed.)

Shapiro, Carl and Varian, Hal R. (1998) "Pricing Information," Information Rules: A Strategic Guide to the Network Economy.

The E-Learning Developers Journal. (2002) "Six Principles of Effective E-Learning: What Works and Why."

Twigg, Carol (2002). "Quality, Cost and Access: The Case for Redesign." The Wired Tower. Ed. Matthew Serbin Pittinsky.

Rosenberg, Marc J. (2001) E-Learning: Strategies for Delivering Knowledge in the Digital Age. New York: McGraw-Hill.

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