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THIS WEEK: Development Strategies

Mashups, SOAP, and Services: Welcome to Web Hybrid e-Learning Applications

By Gary Woodill and Carlos Oliveira

In 2002, David Weinberger published a book about the World Wide Web entitled *Small Pieces Loosely Joined*. This metaphor aptly describes the vision of Web-based e-Learning proposed by those who see the Internet as a learning environment based on personal exploration and discovery, collaboration, and freedom. Such a vision is *not*, however, the dominant view of those in educational institutions or in corporate training, who still tend to see the Web as a slick, new medium for delivering instruction based on a set curriculum or on set learning objectives.

Like most dichotomies, the most probable scenario for the near future of e-Learning lies somewhere in the middle. That is, it is likely that there will continue to be a significant demand for learning management systems (LMS) that will register learners, launch courses, track progress and report results. At the same time, there is no question that there is a strong trend (at least in adult education) towards personalized, collaborative, learner-controlled online learning experiences. In this article, we will describe a set of technologies that can unite these two sides of e-Learning, providing a flexible environment that provides a mix of options for each individual learner.

From "page turner" to complexity

Most new technologies are extensions of ideas and concepts of the past. E-Learning using the World Wide Web is no exception, as early ver-

We often see or hear predictions from experts and analysts about the direction e-Learning is headed. In fact, there is no single direction in which e-Learning developments are moving. Instead, e-Learning is evolving along a number of fronts, using a variety of models and technologies. The result looks more and more like a world of distributed multi-channel learning, using resources and requirements in a mix that will be different for each person. Join the authors as they explore these developments and explain how they are using SOAP and Web services to create personalized collaborative learning management systems (PCLMS).

A publication of



sions imitated either the page turning of books, or the instructor-controlled classrooms of modern industrialized schooling. Only now, a decade and a half after the invention of the Web, have new forms of learning and teaching emerged that use the unique possibilities of networked communications – sharing and collaboration. These new forms of education and training are possible because of the qualities of the network, and are likely to change teaching and learning forever.

A quick review of e-Learning history

E-Learning pre-dates the World Wide Web by several decades. This sometimes surprises people whose awareness of computer-mediated instruction is more recent, and a summary of this history may be useful to some readers.

The idea of computer-based education first emerged in the late 1950s with proposals for building “teaching machines.” In the 1960s, Donald L. Bitzer started the PLATO system (Programmed Logic for Automatic Teaching Operation) for mainframe computers. Control Data Corporation expanded and further developed PLATO between 1976 and 1986.

The Internet started as a way to transfer messages from one computer at a university or research lab to another computer in the network. Email and file transfer were the original educational applications as academics learned that they could distribute their digital documents to others without using paper. Rudimentary discussion forums and list servers based on early email protocols followed.

With desktop computers becoming common in the 1980s, stand-alone educational applications appeared for individual learners on their own computers. By the late 1980s, *client-server* architecture became common, whereby applications and data could be held on a server and used by many client programs on individual computers.

The invention of the World Wide Web protocols in the early 1990s allowed text strings or graphical objects to be linked through a “universal resource locator” (URL) to online resources from any server that was accessible to the network. Various browsers were then developed as “thin clients” with most of the functionality of applications and the data that they needed residing on designated Web servers.

Early versions of Web-based educational applications were either “page turners” that presented lots

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of text and graphics, or they were imitations of software applications that had previously been built to run on individual desktops. The problem with this approach is that Web-based educational software has often been a simulation of the worst kind of university or high-school class – a presentation on the material, followed by a test.

As one of the authors of this article (Gary Woodill) noted in a white paper in 2004, “The principal reason why most people have trouble suffering through an e-Learning course is that there is usually nothing to do but read, look, and take a multiple choice test. Most often there are no instructional activities that deeply engage the mind of the learners, and ‘interactivity’ mostly consists of turning from one screen to another. This is especially problematic for the under-40 generation, which has grown up with fast-paced videogames, movies, and television programs. Reading a lot of text on a screen simply doesn’t cut it for them.”

We need to recognize that learning is multi-dimensional, with multiple sensory inputs and many different sources of experience. Learning is dynamic and complex, as humans, individually and collectively are “complex adaptive systems” and learn in individual ways. The adaptive nature of human learning is the result of feedback loops and external cognitive aids that influence what and how we learn.

The field of e-Learning is now starting to build online educational experiences and tasks that begin to take the complexity of human cognition into account. “Distributed and interconnected systems have become the norm for new development efforts to the extent that the word ‘application’ itself might have to be redefined,” says Gregor Hohpe.

The move to multi-channel distributed learning

Although it is not surprising, the first generation of online learning technologies and content is generally too simplistic to fit the complexities of human learning. Thought leaders in the field recognize this when they speak of moving to Web 2.0 or e-Learning 2.0. In this new view, the “online learning landscape” needs to be highly varied, dynamic, collaborative, responsive, and personalized. Given the many interesting ways to connect people with learning materials and with each other, there is really no reason to continue with the dominant “page-turning” presentation model of e-Learning. As Brent Davis, Dennis Sumara, and Rebecca Luce-Kapler point out:



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"... [electronic] media operate at a low information level – one that has been deliberately adjusted to suit what consciousness is able to accommodate. And so, while these technologies give access to immense stores of data, they operate at a very low level of stimulation. Human sense organs, however, function at a capacity that is about one million times greater than conscious perception. As such, abundant use of the so-called 'information technologies' may actually result in a starvation of the senses, and information poverty. Traditional teaching strategies might also be criticized on the basis of such information poverty. These practices tend to be adjusted to the limitations of consciousness, but often fail to consider the breadth of human sensation."

There are many different types of learning, depending on what is being learned, the learning environment, and the characteristics of the learner. Part of the reason we tend to misunderstand the complexity of learning is because we see the results of learning as "knowledge" – which we tend to think of as a commodity that can vary in quantity from one person to the next. We tend to view knowledge as a *thing*, our ideas about learning center on metaphors of acquisition, processing, absorbing, building, or flowing. But knowledge is usually *situated*, and is often shared and collectively produced, as Brent Davis and his colleagues also point out.

While the first generation of e-Learning practices and technologies is being swept away by an explosion of new forms of online educational experiences, *e-Learning* is morphing into multi-channel *distributed learning*. It is not a case of e-Learning simply being mixed with "face-to-face" learning to form blended learning. Rather, *all* learning will be multi-channel learning. The "e-" in e-Learning will gradually disappear, as electronic support for learning by any means becomes invisible, ubiquitous, and taken for granted – see Donald Norman's *Things That Make Us Smart* for more on this evolution.

E-Learning in the workplace and, to a lesser extent, in schools and universities, has moved from early text-based CBT systems to full scale multimedia presentations. It is about to change again into a highly fragmented "learning landscape" where online presentations will be only one option in a myriad of choices for learners and instructors. Multi-channel distributed learning combines many forms of face-to-face learning with dozens of learning technologies and data sources to produce a rich learning experience that is dynamic, personalized, and relevant to each person's learning needs

and goals. In recent research (2005), Gary Woodill has identified over 50 different content formats, 60 online technologies, and 40 services used in e-Learning offerings today.

For the most part, this developing multi-channel distributed learning environment is a "self-organizing" complex adaptive system, and, because of that, it is difficult to predict exactly how it is all going to turn out in the next five years. But there is no question that a major shift is taking place – a turn from instructor-centric curricula toward learner-centric searches for relevant learning resources as needed. The shift has sometimes been characterized as changing from "push" to "pull" technologies. But the change is actually from instructor-controlled classroom learning and instructor-controlled e-Learning to a *mix* of approaches that includes instructor control when appropriate (for specific certifications, for example), along with a variety of dynamic multi-directional channels of resources and requirements from which learners can explore, select, and "pull" content. This mix will be different for each person.

Multi-channel distributed learning and its support technologies are developing rapidly, and e-Learning is at the beginning of a new technology innovation curve. As Stephen Downes points out, much of the pioneering work in this area is carried out at various universities and research labs around the world, and is a mix of open source and protected source initiatives.

E-Learning 2.0: The "whole product" for a market of one

Instead of moving among discrete applications in courses, learners in the near future will be accessing "hybrid applications" or "mashups" in which data will be mixed together from many different sources, in a unique blend for that learner at that moment. The "content" for educational experiences will be based on distributed applications and data sources. This is all possible because of an explosion of innovation in information and communications technologies (ICT) applied to helping individuals and collectives to learn.

It is, according to Downes, "A shift from the idea of the Web as *medium* to the idea of the Web as *platform*." The unique traits of this emerging e-Learning platform include the following:

- *Increasing speed of computers*: Photonic, genetic, and quantum computing will make today's computers seem like dinosaurs in five years.
- *Interactivity beyond clicking on links*: As we develop computer interfaces that involve all the senses and programs that truly allow individuals

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to make differences in their own learning landscape and to contribute to the learning of others, interactivity will morph into real engagement and involvement in the networked world.

- *Dynamic learning:* With new forms of interactivity and innovative uses of the possibilities inherent in this new platform, content will shift from something that is static information for an individual to absorb, to the creation of dynamic educational experiences that will involve all the senses and engage thinking minds. Users interacting with each other will generate much, but not all, of the available content, and they will be able to post their content to networked repositories. Distributed content will loosely couple so that it can be reconfigured in a myriad of ways depending on the context and the personal profile of each learner.
- *Aggregated content:* The use of content “feeds” (such as *Really Simple Syndication*, or RSS) will increase, and to manage the huge amount of content that will be available, content aggregators will gather what each learner needs on an individualized basis.
- *High-speed networking to anywhere in the world:* Countries that have traditionally been unable to afford the level of computer technologies enjoyed in North America and Europe will be brought online with the laying of fibre optic cable, wireless wide area networks, and inexpensive computers (under \$100).
- *Real-time collaboration:* All of the above changes will allow people to organize and work together via computer networks, whether they are in the local area or halfway around the world.
- *Digital representations and transformations:* As more and more of the world’s assets are digitized, they will be available in new flexible formats.
- *Increasingly sophisticated algorithms:* Algorithms, or repeatable computer procedures, are the key to innovation. Thousands of companies and research organizations around the world are engaged in a frenzy of research and development activities to develop better algorithms for any human process that a computer can replicate.
- *Huge storage and retrieval capacity:* Storage of digital information has become massive, and extremely cheap. It is now possible to keep everything being produced on the world’s computers.
- *Individualization, customization, flexibility, adaptability, personalization:* With new personalization software able to make recommendations for what learners need next, a dynamic learning profile for each person in the world, based on their

learning preferences, interests, and abilities, will influence search results and the learning experiences offered.

- *Constant availability:* Ubiquitous embedded computing is already here. Cars, roads, homes, businesses, etc., all have computing capacities that are always available, and which are often embedded in the environment. The computer is truly becoming invisible and mobile.
- *Improved simulations and visualization of complex data:* The most startling change for learning in the near future will be the simulation and visualization of very complex phenomena, in order to understand and change the world.
- *Support for collective human endeavors through digital technologies:* This means an increase in the practice of “collaborative cognition” (as David Bearison and Bruce Dorval referred to it in 2002) and a sense of “collective intelligence,” a topic that will be increasingly important as the world faces difficult environmental and political problems.
- *Multiple channels for learning:* While some individual learners will want to find their way through the maze of information, educational materials, and experiences available to them in the new “learning landscape,” many others will want (or may be required) to be guided in their online learning. Learning experiences will be multi-channel, sometimes in one direction, and other times in two or more directions.

With all the possible variation in content, there is a need to coordinate workflows in e-Learning and to produce a unique personalized multi-channel mix of both push and pull educational experiences for each learner. With configurable platforms each user can, in effect, have a “private label” application that serves up the optimal educational material for his or her needs.

E-Learning 2.0 requires flexible, configurable software that can manage and track learning while coordinating and delivering a wide range of information resources and educational experiences. Advocates for e-Learning 2.0 are trying to piece together such a system from a wide variety of open source initiatives, including virtual learning environments, personal learning environments, wikis, blogs, and content repositories. We believe that a more effective way to create a dynamic educational environment is to use the collaborative strengths of SharePoint and Live Communications Server from Microsoft, supported by a configurable Learning Management System (LMS) such as LearnFlex™. In the sections that follow, we’ll show you how we and our colleagues did this using

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SOAP protocols and a set of service-oriented technologies that connect the loosely joined pieces of the Web together.

(In the interest of full disclosure, LearnFlex™ is a product of our company, Operitel.)

SOAP and Web services

The Web is made up of an extremely large collection of software *objects*, all expressed in binary code. Many of these objects are software programs, which can range from a single statement to massive amount of computer code. Programs can be “stand alone,” that is, run all by themselves, or they can be dependent upon other programs to supply data or specific functions. In order for two or more programs to talk to each other, they need to have an agreed set of rules or *protocols* of how to communicate with each other. For example, HTTP (*HyperText Transfer Protocol*) is the set of rules of how a request for a specific Web page can be made to a Web server. Similarly, FTP (*File Transfer Protocol*) provides the rules for sending files across the Internet.

SOAP originally stood for *Simple Object Access Protocol*, the set of rules for accessing a software object on the Internet. The meaning of SOAP has since broadened to include rules on how two software programs can communicate and work with each other, also called “object interoperability.”

Using SOAP, programmers can build programs that communicate across the Web and exchange data with other programs. Such programs can “expose” their functions or data to other programs, and be “consumed” by them. The programs that do this are called “Web services,” and the organization of software to facilitate these arrangements is called “Service Oriented Architecture” (SOA). (See Thomas Erl’s book on SOA, listed in the References at the end of this article.)

Some Web services are public, and can be linked to by any software with the knowledge of how to read the information from the Web service, while other Web services require authorization through the use of security procedures. When a Web site takes data from several Web services, and perhaps mixes it with its own data, such a site is referred to as a *mashup* or *Web hybrid application*.

Any Learning Management System (LMS) with built-in Web services can be part of a mashup. By integrating data and functions from other types of programs, such as those for collaboration, document management, communications, etc., the LMS

Table 1 “Learning Supports” from SharePoint 2.0

Learning Supports	SharePoint 2.0
Connected Workspaces	Four levels of connected workspaces – individual, team, division, and enterprise – hub and aggregator for all four levels
Collaboration Applications	Facilities for meeting workspaces; blogs, with comments; wikis; calendars; surveys; discussions; email integration; and offline collaboration using Outlook and Groove
Content Management	Integrated facilities for documents, records, and content management; support for spell check, tables, and stylesheets; recycle bin for deleted items; library/list content types will control metadata, views, workflows, and events; information rights management; version control for major and minor revisions with enforced checkout; extensible file format support; content templates; content can be associated with workflows and/or events; imaging service to create and maintain a picture library
Content Syndication	Content can be syndicated via RSS on a per-site or per-list basis
File Format Conversion	Easy file format conversion; rendering of spreadsheets as HTML; Access will treat SharePoint site data as data sources; easy, no-coding creation of dashboards from Excel spreadsheets; PowerPoint “Slide Library;” Outlook integration
Workflow Development	FrontPage wizard for workflow development; workflow templates; digital signature integration
Web site Development	Facilities to make it easier to build and/or manage sophisticated internet and/or intranet sites
Integration	Much easier to integrate enterprise applications, custom databases, and Web services
Forms Creation	Ability to create forms with ASP.NET controls
Lists and Data Management	List creation tool; multiple list views; version history for all lists and libraries showing what changes were made; project task list; Gantt chart view of any list; email to a list for posting; cross-list Web views
Formatting	Ability to send SharePoint lists to mobile devices
Feature Selection	Selected deployment of major features
Search	Search features include “Best Bets” and alternate suggestions
Personalization	Enhanced MySites with aggregation, personalization, and social networking
Authoring Tools Used	Extensive use of Front Page for site design; publish InfoPath forms as SharePoint sites; Front Page-based Template Designer for content management
User Interface Management	Easy global change of UI via master pages
Languages	Out-of-the-box support for multi-lingual deployments
Security	Item-level permissions in all libraries and lists
Connectivity	Uses Web services and SOAP protocols; Web parts
Messaging	Email alerts, with filters; submit postings to WSS discussion boards via email; email archiving
Application Launching	Connectable Web parts; Web services; connections to APIs of external applications
Communications	Site level: Instant messaging, discussion forums, messaging and alerts. Connects to Live Communications Server for chat
Polls and surveys	Surveys built-in
Administrative Controls	Tools to create and manage lists

(SharePoint information adapted from Miller, 2006)

becomes capable of tracking the formal aspects of learning, while simultaneously providing an informal collaborative environment.

We have taken this approach in several cases, using a combination of LearnFlex™ and Microsoft SharePoint. These hybrid sites have a single sign-on for learners, instructors and administrators, making them powerful e-Learning portals. A mashup can be extended to add features through the use of Web services. For example, in one project we added Microsoft Customer Relationship Management (CRM) software into the mix.

It should be noted that Web services provided by an LMS will work with any other Web program that “consumes” Web services, and that SharePoint also can provide Web services to be consumed by external applications. The combination we have chosen to use offers a number of advantages. SharePoint offers many useful functions that support personal and collaborative learning, while LearnFlex™ is highly adaptable, changing its presentation of graphics, features, languages, and business rules based on the personal profile of each user.

Uniting the two programs allows us to develop *personalized collaborative learning management systems* (PCLMS) that meet the unique set of requirements of each client for the functions of e-Learning 2.0, while maintaining the ability to register, track and report on formal learning transactions.

Configuring SharePoint for collaborative e-Learning

While the “Learning Gateway” solution from Microsoft uses Windows SharePoint Services (WSS) for its base portal layer, it can be greatly enhanced with an additional set of educationally relevant Web parts (explained in the next paragraph) from an Enterprise LMS to provide a capable educational solution for online learning. As shown in Table 1 on page 6, SharePoint, when properly configured, serves up most of the infrastructure needed for the learner-centric functions of e-Learning 2.0.

Integration of SharePoint with the LMS

One of the strengths of Microsoft SharePoint products and technologies is the ability to provide configurable and extensible user interfaces for external vendors to add functionality, accomplished by writing a set of small programs or plug-n-play components called “Web parts” that can be embedded into a SharePoint Web site. Each Web part “consumes,” with proper authorization, the

Web services provided by an external program. (Web parts can have other functions, and can be written for other Web applications that use Version 2 of Microsoft’s .NET framework. Web parts can also be written to consume Web services using non-Microsoft languages, as long as they use SOAP.)

In the educational arena, our experience in a number of projects is that adding Web services from a configurable learning management system (such as LearnFlex™) greatly enhances the educational power of SharePoint. Learning management functions that an e-Learning developer might want the LMS to supply as Web services include the following:

- Individual learning plans; personal profiles that can be used to change languages, course offerings, look and feel, and business rules
- Email alerts with filters; internal messaging for courses
- Completely configurable registration workflow; different registration workflow possible for each organizational unit; registration for all types of classes, including face-to-face, blended, and on-line courses
- Tracking and reporting of classroom assessment results
- Providing class lists, course catalogues, subjects, and departments
- Learner status information
- Resources management module
- Launching of courses and educational events from each individual learning plan
- E-Commerce – built-in and completely integrated with the LMS
- Conference and workshop management module, including e-Commerce for conference fees
- Tracking requirements for diplomas or certificates, including optional and mandatory requirements; issues customized diploma on completion
- Full tracking and reporting of competencies, based on job position or individual profile
- Assessment engine with over 20 question types; insertion of performance data and external assessment results; reporting and descriptive statistics
- Virtual classroom functions including communications, note-taking tools, and course libraries
- Instant messaging, discussion forums, chat, messaging, and alerts at the course level
- Built-in surveys and quick polls within the virtual classroom
- Achievement records for each learner
- Built in custom report generator plus a selection

Instead of moving among discrete applications in courses, learners in the near future will be accessing “hybrid applications” or “mashups” in which data will be mixed together from many different sources, in a unique blend for that learner at that moment. The “content” for educational experiences will be based on distributed applications and data sources.

of standard reports

SharePoint is both a very useful collaboration environment and a configurable connectivity platform using Web parts and Web services. Paired with a capable LMS, SharePoint can be up and running in learning environments in a relatively short period. This combination has huge potential in education and training markets.

Conclusions

Given the explosion of the variety of online educational supports, no single product on the market can cover all the possibilities as we move into a world of distributed multi-channel learning. While there is a wide variety of open-source initiatives to support e-Learning 2.0, they are generally not yet integrated with each other, and, for the most part, are still in the development stage. However, one can realize much of the functionality of the projected applications and benefits from e-Learning 2.0 through Microsoft tools such as SharePoint and Live Communication Server, with rapid configuration for specific educational settings using LMS Web services all connected with a common portal interface using SharePoint Web parts. Once this is accomplished, enterprises have a very powerful learning platform that can support the complexities and dynamics of personal collaborative learning. 

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Additional information on the topics covered in this article is also listed in the Guild Resource Directory.

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