



Learning and Information Management in Education – As We May Learn

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Introduction

In 1945, Vannevar Bush,¹ who served as science adviser under President Franklin Roosevelt, published an essay entitled “As We May Think,” in which he described what we now know as hypertext and digital libraries. He proposed a system where documents related to an idea could be linked and followed down trails of logical associations. Bush envisioned technology as providing access to the rapidly expanding world of knowledge while extending the ways in which we make connections and construct knowledge — in other words, expanding our capacity to learn.

Almost 50 years later, in 1993, the National Center for Supercomputing Applications at the University of Illinois released a technology called a web browser for what was then called the National Research and Education Network (NREN). This new technology was called Mosaic.² This invention made hypertext and the World Wide Web a reality for the world at large. Mosaic became Netscape Navigator; Microsoft introduced Internet Explorer; and within the space of five years, the web had brought everything from bookstores and live weather reports to auctions and banking into the home and onto the desktop.

Anytime and immediate access to information was a powerful force that affected education as well. Soon after the release of Mosaic, a new generation of Web-based instructional technologies began to emerge. Some of those technologies were tools for creating and presenting information in the form of rich, digital multimedia. Other technologies emerged that helped leverage digital content in learning settings. This latter class of technologies was dominated by what are now called virtual learning environments, course management systems, and learning management systems.

Early course and learning management technologies were mostly focused on taking classroom instruction online. They provided simple tools for authoring and publishing content, automated administrative functions, presented online classroom resources, managed instructional activities, added a few collaboration tools such as bulletin boards and chat rooms, and provided 24/7 access to content and services. The widespread adoption of these systems suggests that they offered a good solution to managing online teaching and providing access to content online: Green³ has noted that by 2003, approximately 83% of all U.S. post-secondary institutions had some kind of course or learning management system on their campus.

However, it has been much harder to come by data demonstrating that learning management systems have substantially changed the way we learn. The lessons of the past decade have taught us that putting courses online is easy; improving learning is much harder.

In 1945, Vannevar Bush saw a future in which the structuring and management of information would form the core of discovery and learning. While enormous progress has been made in creating the kind of world that Bush envisioned, evidence of the web’s true impact on learning efficacy continues to be mixed.

If we are to use the web to improve learning, we must return to Bush's vision. We must understand the web's effect on information, and we must manage the web to ensure that information is available, accessible, accurate, and usable — when and where and by whom it is needed. We must do a better job of managing information and of connecting people to it.

Fortunately, several developments within the learning technology community are moving in this direction. They include federations of digital libraries and repositories and service oriented frameworks that encourage compatibility among course management systems, publishing tools, and content formats. Part I of this paper examines these developments and where they might lead.

A Global Federation of Learning Resources

Perhaps the most striking characteristic of the Web is that it offers ready access to more information than we can handle.⁴ As Gandel, Katz, and Metros⁵ put it, we live in “an era of abundance.” The problem we face is not a lack of information but how to find the information we need. This is why Yahoo! is the most used site on the Web⁶ and why search engines such as Google are arguably the most commonly used learning tools.

But search engines and directories have their limitations. Quality and relevance are important attributes of resources used for learning, and learning takes place in context. Furthermore, search engines miss significant amounts of important content, including digital multimedia content, dynamically generated content, databases, and content behind institutional firewalls.

To address this, a new global federation appears to be in the making. Anchored by national and international projects⁷, the members of this federation are educational digital libraries and learning object repositories. These allow users to deposit resources (or links to resources), assign appropriate metadata, search for resources, and access the resources they have found. What makes the digital libraries and repositories into a federation is that although they are completely separate entities, they are linked so that they may be simultaneously searched and used as if they were one⁸.

The members of this global federation will vary in size, scope and character. Some will be institutional repositories that capture the expertise of resident faculty, while others will represent national or international efforts. Some will only accept content from a specialized community while others will be broader and more open. All, however, will have important characteristics in common:

- All resources accessible through the federation will be contextualized for learning through the use of metadata.
- All resources will to some extent be validated for accuracy and quality, either by review or by virtue of their provenance.
- All members of the federation will likely implement a rights management framework that includes explicit usage licenses appropriate for the educational community.
- All members of the federation will be committed to the use of open standards and extensible tools.

The resources available through this federation will not be restricted to Web sites. They will include dynamic content, databases, image libraries, interactive content, software and other resources relevant to learning. The resources will be available to support the type of online courses that are common today while also accommodating the disaggregation of course content so that courses are configurable at a modular, unit or lesson level. Resources will be directly available for use by authors, students, instructors and, significantly, by software applications, with or without the intermediation of an instructor. Furthermore, resources will be contributed to and from all of these same source organizations, entities and individuals. . The federation will be a living and growing source of rich multimedia content that will serve as a global foundation for learning, supplementing the World Wide Web as a global source of information. How close is this global federation to being a reality? In fact, surprisingly close. National examples of such federations, such as the Multimedia Educational Resources for Learning and Online Teaching (MERLOT), exist⁹ today, as does federated searching among international learning object repositories¹⁰. Commercial¹¹ and open source applications¹² have been developed that allow learning object repositories to be created with relatively little technical effort, and the library community has recognized the importance of institutional repositories^{13,14}. Standards exist that permit software applications to search and retrieve resources from repositories.

The problems that need to be overcome are, if anything, economic and political. Given that there is high value to being able to access resources from other repositories and low technical barriers to entry, there is legitimate hope of success.

Looking Beyond Content

The federation of resources described above provides the scaffolding for the overabundance of undifferentiated content available on the Web. This embarrassment of riches is often attributed to the principle that “content wants to be free,¹⁵” but a better mantra might be that knowledge wants to be shared.

We humans, after all, are communicators. A long series of inventions, starting with language and progressing through writing, printing, and modern information and communication technology, have made it possible to share knowledge more easily, more speedily, more accurately, and more globally. With today’s technology you can not only look things up — you can also process data, ask questions and get immediate responses. In cyberspace, the books can talk back.

The responsive and dynamic nature of today's information network is significant for empowering engaging, technology mediated learning experiences, where information assets such as books, websites and applets can stand alone or serve as a foundation for other learning activities. The connectivity provided by mobile devices and online communities offers opportunities to learn from others as well. These "others" are not just teachers but also peers and experts who can bring a multiplicity of perspectives that have never before been so accessible. Nor are people the only resource that can make online learning more engaging. Simulation technology, the ability to access live data, and even basic Web-enabled interactivity allows students to be active participants who learn not only by listening and reading but also by exploring and communicating.

Service Oriented Frameworks

An educational environment should be able to combine information available on the Web and from digital libraries with networked communities, virtual realities, and live data. But how will such combinations be implemented? How and when will the education community have the chance to engage in the experimentation needed to discover what works and what doesn't?

Part of the answer lies in a shift in thinking that has occurred in the general information technology community. Stung by the difficulty of maintaining large and complex software systems and of getting them to work well together, the designers and developers of enterprise and e-business software are taking an approach in which systems are broken up into modular services that function independently and that exchange information using open standards.¹⁶

Not surprisingly, similar ideas have come to the fore in the learning technology community. Projects such as the Open Knowledge Initiative,¹⁷ Sakai,¹⁸ and the JISC e-Learning Programme¹⁹ are creating "frameworks" in which the functionality provided or required by online learning environments is factored into independent services. These services can call upon other services and can also be combined in new ways to extend functionality.

The impact of these initiatives is such that even commercial, proprietary learning management systems are reconfiguring platform functionality to accommodate and allow the integration of standards-based and open source third-party services.

Putting It All Together

One reason for having service oriented frameworks is to do a better job of implementing and maintaining existing functionality. But the real boon comes from the ability to add new services and combine them with existing services. This is the vision being pursued by the projects mentioned above as well as by many commercial software vendors. We are already seeing integrations, as in the case with the Blackboard and the ARIADNE Foundation, where course management systems can search and retrieve resources from digital repositories and can integrate third-party products into their environments^{20,21}. This points to a future where content, administrative and collaboration services can be easily combined into learning experiences. With content under control and services in place, we will finally be able to unleash the creativity of the educational community and expand the limits of how we may learn.

¹V. Bush, V. "As We May Think." *The Atlantic Monthly* 176 (July 1945): 101–108.

² See

<http://groups.google.com/groups?selm=MARCA.93Mar14225600%40wintermute.ncsa.uiuc.edu> for the first release of Mosaic.

³ K. Green. *Campus Computing 2003, The 14th National Survey of Computing and Information Technology in American Higher Education*. The Campus Computing Project: December 2003.

⁴ The Internet Systems Consortium (www.isc.org/index.pl?/ops/ds/) reports over 200 million Web hosts as of January 2004. At the time of this writing Google claimed to be indexing over 4.2 billion Web pages.

⁵ P. Gandel, R. Katz, and S. Metros. "The 'Weariness of the Flesh': Reflections on the Life of the Mind in an Era of Abundance." *Educause Review* 39, no. 2 (March/April 2004): 40–51.

⁶ Yahoo has the highest Alexa traffic ranking as of the writing of this paper.

⁷ Relevant projects include JORUM in the UK (www.jorum.ac.uk), EDNA Online in Australia (www.edna.edu.au/edna/page1.html), ARIADNE in Europe (www.ariadne-eu.org), EduSource in Canada (www.edusource.ca), and the NSDL in the United States (www.nsd.org).

⁸ More precisely, the records from each digital library and repository may be "harvested" by others using the Open Archives Initiative Protocol for Metadata Harvesting, (www.openarchives.org/OAI/openarchivesprotocol.html). This protocol allows a search to return results from all the members of the federation. The results contain links to the resources.

⁹ The National Science Digital Library (www.nsd.org) is an example of such a confederation on a national scale.

¹⁰ See the MERLOT federated search page (<http://fedsearch.merlot.org/main/search.jsp>).

¹¹ A list of learning object repository solutions can be found at Learning Object Repository Software (www.edtechpost.ca/pmwiki/pmwiki.php/EdTechPost/LearningObjectRepositorySoftware).

¹² *A Guide to Institutional Repository Software*, 2d ed. New York: Open Society Institute, January 2004.

¹³ R. Crow. "The Case for Institutional Repositories: A SPARC Position Paper." The Scholarly Publishing and Academic Resources Coalition. August 7, 2002.

¹⁴ C. Lynch. "Institutional Repositories: Essential Infrastructure for Scholarship in the Digital Age." Association of Research Libraries, February 2003.

¹⁵ See www.anu.edu.au/people/Roger.Clarke/II/IWtbF.html for possible derivations and proper attributions of this quote. It is often attributed to Stewart Brand.

¹⁶ The terms associated with this approach are service-oriented architecture and web services.

¹⁷ G. Collier and R. Robson. "What Is OKI?"

http://web.mit.edu/oki/learn/whtpapers/OKI_white_paper_120902.pdf.

¹⁸ See www.sakaiproject.org.

¹⁹ See www.jisc.ac.uk/index.cfm?name=elearning_framework.

²⁰ P. Vandepitte, L. Van Rentergem, E. Duval, S. Ternier, and F. Neven. “Bridging an LCMS and an LMS: a Blackboard Building Block for the ARIADNE Knowledge Pool System.” World Conference on Educational Multimedia, Hypermedia and Telecommunications 1 (2003): 423–424.

²¹ See www.melcoe.mq.edu.au/projects/iis&r.htm for information about the Australian COLIS and Interaction of IT Systems and Repositories Project. This project demonstrates how learning technologies can be integrated with repository technologies.