Preparing for the Long Tail of Teaching and Learning Tools

Charles Severance and Stephanie D. Teasley, School of Information, University of Michigan,
1075 Beal Ave, Ann Arbor, MI, 48109-2112
Email: [csev, steasley]@umich.edu

Abstract: In this paper we apply the concept of "the long tail" (Anderson, 2006) to teaching and learning tools to discuss how the limitations of current Learning Management Systems (LMS) can be overcome to allow instructors to customize the technology they use to support their own classroom practices. Learning tools in the long tail are those that are widely used by a subset of instructors - tools specific to large courses or tools specific to a particular field, and tools that are only used in a few courses or a single course. Using several examples from courses taught on our campus, we show how to put extensibility in the hands of the instructors to create knowledge-age learning technologies that are customizable, interactive and controlled by users.

Introduction

Increasingly, learning management systems (LMS) such as Blackboard or Sakai are seen as one of the most essential Enterprise Services in education. A recent survey of 115 American universities has shown that 89% of students reported that they had taken a course that used a LMS (Smith, Salaway, & Caruso, 2009). In addition, a 2009 survey of US school district administrators estimated that more than a million k-12 students took online courses in the school year 2007-2008 (Picciano & Seaman, 2009). That these systems are basic infrastructure for learning in higher education is already a fact; that they are as common in K-12 education may also soon be true (see Means, Toyama, Murphy, Bakai & Jones, 2009). Yet what do we know about using LMS well for teaching and learning? How can we help teachers to incorporate the promise of Web 2.0 technologies into their classrooms? In this paper, we examine the trends in the evolution of learning management systems and how those systems are currently being used in higher education. We then propose how learning management systems must change by leveraging the "the long tail" (Anderson, 2006) of teaching and learning tools. These suggestions apply to higher education specifically, but also provide guidelines for development and use that may ease the transition as LMS use permeates K-12 education.

Background

Few other campus enterprise systems have the requirements of 24x7 availability, with the ability to scale to support over 10,000 simultaneous users during peak loads. On many campuses, learning management systems must run for months without allowing for an outage to perform major software upgrades. These requirements lead to a very careful and conservative approach to upgrading or changing the LMS software in the middle of a semester. This trend is coupled with increasing penetration of the LMS system as measured by the percentage of students and faculty who are using the LMS (Smith, Salaway, & Caruso, 2009). On our own campus, the annual IT survey shows that 99% of students and 81% of faculty have used our LMS for at least one course in the past year (Lonn & Teasley, 2009).

Because LMS use has become so pervasive in higher education, we have an opportunity to analyze how the average instructor uses these systems across many different subjects. Most analyses of LMS use (Hanson & Robson, 2004; West, Waddoups, & Graham, 2007) point to a distribution that follows the "long tail" typically found in analyses of most online systems (Anderson, 2004). Specifically, the long tail refers to the statistical phenomenon of a power law or Pareto distribution where few items comprise the most use but there is a long tail of many items used with a much lower frequency. This distribution is clearly seen with the use of tools available within LMS, where a few tools are heavily used then usage drops off dramatically after five or six core tools. Overall, document management and broadcast-oriented communication tools (Content Sharing, Assignments, Announcements, Schedule, and Syllabus) comprise 95% of all user actions (Lonn & Teasley, 2009; Hanson & Robson, 2004). By contrast, the tools that are more interactive (Chat, Discussion, and Wiki) are not used as much. While research coming from the Learning Sciences would have much add to the current literature addressing the relative value of teaching with one tool or another, in this paper we leave this to others and focus here on the fact of current LMS use and how to empower instructors improve their own use of these systems.

The two trends of "LMS as critical infrastructure" and "only a few of the tools are heavily used" leads to the inevitable conclusion that LMS development efforts need to focus on improving the core tools which make up the LMS and spend less effort on the long tail of tools. If the trend was extended to infinity, LMS systems of the future might have exactly seven tools which are never changed or upgraded. While this will insure that the core infrastructure is solid, consistent, and reliable, it will have a tremendous negative impact on the ability for instructors and learners to innovate and find new ways to use technology in education. One possible path forward is that learning management systems will go "underground" - where in order to experiment with innovative ideas, savvy faculty host their own learning management systems under their desks or perhaps run software on their own ISP account. The "Edupunk" movement (e.g., Kuntz, 2008; Young, 2008) expresses this sentiment in a call-to-arms to reject commercial LMS products. This approach does allow instructors to be innovative, but it adds the burden of maintaining a production infrastructure and saps precious energy away from their teaching efforts. Another extreme reaction to the perceived limitations of current LMS is a call to "teach naked" and reject the use of technology in the classroom altogether (Young, 2009). This, however, seems like a “baby with the bathwater” solution that is not likely to be realistic for today’s students who are considered to be the “net generation” and “tech-savvy Millennials” (Junco & Mastrodicasa, 2007).

Rather that going Edupunk or even teaching naked, we believe the solution to this problem is to add features to LMS systems that allow the core functionality to focus on scalability and stability while allowing innovation at the edges by encouraging more use in the long tail. The key to this approach is that we need to add features to LMS systems so that they can be extended without adding a new feature on to the LMS servers or needing to upgrade the LMS to a new version (Severance, Hardin, & Whyte, 2008). The extensibility needs to be placed in the hands of the instructors rather than only in the hands of the LMS system administrators. This DIY (Do It Yourself) attitude reflects the growing capacity of Web 2.0 applications to put users in control of the content and distribution of materials. In popular culture this DIY capability can be seen in zines, self-publishing, and music re-mixes. We believe this approach can be extended to educational tools as well and fulfill Collins & Halverson’s (2009) call for knowledge-age learning technologies to be customizable, interactive and controlled by users. Only then can we meet both the needs of enterprise production and innovative approaches to teaching and have the best of both worlds. The average instructor who only uses 5-6 core tools has access to a scalable and stable toolset, while the instructor with a new idea is allowed to bring that idea into their class in a few days or weeks of effort - all without destabilizing the LMS production system.

Teaching Tools in the Long Tail

We see learning tools falling into three basic categories: (1) the core 5-10 tools used by nearly every teacher, (2) a set of tools that are widely used by some subset of the teachers - perhaps tools specific to large courses or tools specific to a particular fields like mathematics, and (3) tools that are only used by a few courses or even a tool purpose built for a single course. As we look at the nature of the tools in (1) and compare them to the tools in (3), we are likely to see a transition from tools that "manage" the learning process towards tools that support the learning process. The tools in category (2) are likely a mix of management and learning. This leads to a "long tail" effect where the more learning-oriented tools are in the long-tail. While each individual tool may have a very small "market share" when aggregated together, these long-tail tools may well represent a majority of the overall usage.

The nature of the content-oriented tools (category 1) that are used universally is that their features are likely to be useful to every single instructor, regardless of context or discipline. Hence Category 1 tools comprise the bulk of the distribution of use curve. By contrast, the tools in the second category tend to end up appealing to a smaller but identifiable population of instructors. For example, the CAPA testing system uses LaTeX as its question authoring language and as such naturally appeals fields such as mathematics, chemistry, and physics where most of the instructors with a Ph.D. in those fields learned LaTeX to write and publish papers. Furthermore, CAPA provides a very rich (albeit complex) mechanism for generating many equivalent variations of a problem by altering numeric values randomly. This functionality is very useful for courses where many of the problem sets assigned to students involve numeric calculations. While the CAPA system is very popular for use in first and second year physics, math, and chemistry classes with high-enrollment numbers, it is simply too difficult to learn to ever become widely used for fields like literature or the humanities. This naturally limits the *overall* number of courses and faculty who will use a CAPA-based system to a small fraction of the market – perhaps less than 2-3% of the overall courses taught. However, for those courses, CAPA is nearly the *perfect* solution particularly when coupled with the ability to collectively build large question pools across institutions and with some publishers providing CAPA question banks with physics and chemistry textbooks. Since CAPA reflects such a small market share overall, the testing systems provided in mainstream LMS products do not include CAPA-like features and so if you teach a course that needs CAPA – pretty much your *only* choice is CAPA. For tools in the third category, the potential market share is smaller yet and these tools may have very individualized use that can not necessarily be generalized across disciplines or teaching contexts.

In what follows below, we discuss several examples of category 2 & 3 tools in the long tail and provide detail about the ways in which these tools extend instructors’ use of the standard LMS toolset to meet their unique needs. These examples reflect current teaching practice at the University of Michigan where the enterprise LMS is based on the Sakai open-source LMS.

Student Assessment Management System (SAMS)

In our College of Literature, Science, and Arts (LSA), instructors have access to a CAPA-based system called SAMS (Student Assessment Management System) which is heavily used by the physics, mathematics, and chemistry departments. A requirement unique to SAMS is the need to do extensive data mining across the multiple sections of the same course. Since there are so many sections taught by graduate student instructors in introductory-level courses, SAMS must be able to provide regular reports to course coordinators so that problems encountered by individual student-instructors can be diagnosed and addressed as quickly as possible. In addition, error patterns in problem sets seen across sections provides the main instructor with feedback about which concepts and/or formulas need further elaboration in lecture or additional time in section. For these reasons, SAMS is considered to be a powerful tool in achieving consistently high quality in the teaching of these large-enrollment courses.

Despite its important role in the largest academic unit on campus, SAMS is not in the standard toolset provided by the LMS. Since SAMS is written in PERL and the underlying architecture of the LMS (Sakai) is written in Java and because the requirements for SAMS are so complex (e.g., including rules about to who can see which data and reports), it was never practical to re-write SAMS inside of Sakai. For many years students in classes that used SAMS visited two separate sites for their courses: one course site in the LMS and one course site in SAMS. This was confusing and inconvenient for students *and* instructors as the SAMS site had its own navigation, login process, and user interface conventions. After an early version of IMS Learning Tools Interoperability was installed in Sakai, we were able to integrate SAMS into Sakai to share identity and roster information with SAMS without any user intervention. We even created a virtual tool in Sakai that made it look like we have built SAMS into Sakai. Instructors can now simply add the SAMS tool to their course site like any built-in Sakai tool. Figure 1 displays the user's view of SAMS inside of a Sakai course site.

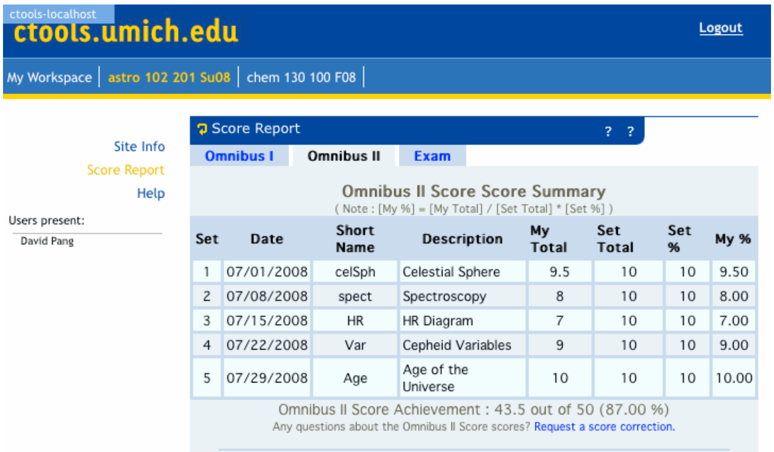

Figure 1. SAMS Running Within Sakai

Effectively the user experience for both the instructors and students is as if the SAMS tool had been ported into Sakai. There is no need to rewrite any software; we only had to add some integration in SAMS to receive and process the IMS Learning Tools Interoperability launch requests from Sakai. This approach also allows the College of LSA to maintain their strategic access to their data, and to independently upgrade and improve SAMS to meet their needs on their own schedule, unencumbered by the Sakai development or production priorities.

This is an excellent example of how we can develop category 2 tools to meet both the enterprise-wide needs in teaching and learning as well as the school-level needs for teaching and learning. The approach allows reuse of the common capabilities of the enterprise systems while allowing schools or departments to address their own unique needs in focused areas of teaching and learning. An enterprise LMS does not have to be a win-lose proposition across campus.

LectureTools

The LectureTools project provides free tools that support interactivity and enhanced modes of learning during lectures. Like CAPA, LectureTools is most useful for medium to large lecture courses where the teaching staff wants to use support interactions between the instructor and student, and between students as part of the lecture experience. Again we see a situation where the overall population of instructors for whom LectureTools is useful is a fraction of the entire set of courses that are taught at the university. And, here again, the functionality provided by Lecture Tools is not likely to be included into the core functionality of most LMS systems.

Like the SAMS project, we developed a similar virtual tool approach to integrate LectureTools into Sakai. Instructors can add the LectureTools tool to their course site like any other tool built into Sakai. Sakai uses IMS Learning Tools Interoperability to launch and provision course sites in LectureTools, giving students and instructors a seamless user experience from a single course site. Unlike SAMS, the LectureTools service is available to instructors at any university in the US and Canada. These additional schools may or may not use Sakai as their LMS. As IMS Learning Tools Interoperability support is added to all LMS, any school can integrate LectureTools into their campus-wise enterprise LMS systems.

We are currently in the middle of a project integrating LectureTools into Blackboard LMS running at a community college and one commuter campus of the large research university as shown in Figure 2. This project will not only demonstrate the ability of LectureTools to run regardless of which enterprise LMS is in use, but provide a model for allowing cross-campus collaboration in teaching specific courses.

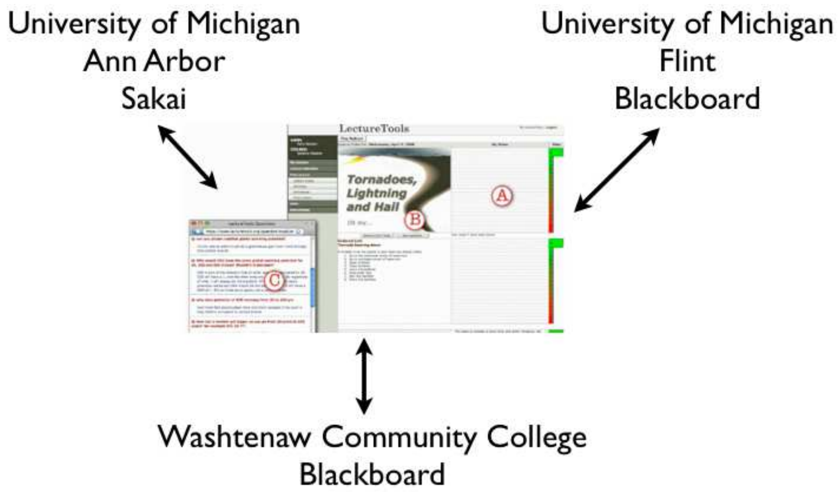

Figure 2. Using LectureTools in Sakai and Blackboard

We are using an open-source Blackboard Building Block that supports IMS Learning Tools Interoperability developed by Stephen Vickers of Edinburgh University [www.spvsoftwareproducts.com]. Once the IMS Tools Interoperability integration is completed, the same tool can be used across these three institutions with each set of users experiencing the tool seamlessly integrated into their local LMS user interface. As this pattern is extended, it allows a cross-institutional community to develop where the common thread is the use of the LectureTools platform to augment their lecture experiences. By combining small pools of interest across many campuses, is it possible to end up with a much larger overall demand for a tool or capability. By reducing the integration costs to nearly zero using IMS Learning Tools Interoperability, we increase the likelihood that these cross-institutional communities will form around particular pedagogy or domain specific tools.

In summary, the middle category of tools, Category 2, are those tools that appeal to some subset of the overall teaching space and are very valuable to that those teachers and learners. By allowing tools to be scoped at a college or department level or perhaps by bringing a cross-institutional community of interest together, we can match the tool with its level of demand. While the core tools are very focused on the management of learning, the tools in the middle category are generally some combination of "learning management" and content or context specific learning. That is, these more narrow tools will often focus on supporting a particular teaching pedagogy or objective rather than simply moving content around and facilitating students' access to that content.

Wisdom of Crowds

In addition to Category 2 tools that have broad use with a small market segment, there are also tools that only appeal to a very tiny population – perhaps as small as a single instructor (Category 3). The exemplar for this category of tools comes from the book "Wisdom of Crowds" by James Surowiecki (2005). Surowiecki's book provides examples of how groups of people can have collective intelligence that surpasses the intelligence of any of its individual members. The author uses examples from social science, economics, and game theory to provide a basis to explain the mechanisms that make crowds wise. Often these concepts are explained in the form of a multi-player game where students play a game and then afterwards the class analyzes player behavior to illustrate the point of the exercise.

Often when teachers use the book "Wisdom of Crowds" they play the games with small scraps of paper and a designated student who "runs" the games. However it is also possible to write computer software that simulates the game and enforces its rules. When computer software is used to run the game, the educational advantage is we can retain the history of player interactions to facilitate a deeper insight into why a player made a move at a particular moment in time. For example, the simplest of the games proposed by Surowieki has a group guess a numeric value such as the number of jellybeans in a jar. First people independently guess the value and then an average the values is calculated.

This game can be played much more effectively on a computer using student laptops or PDA's rather than averaging numbers on slips of paper. Using technology, students experience first hand how their own guesses may be less accurate that the group mean and the visible display of individual guesses shows more clearly how the collective arrives at the correct answer. To implement the software for the game, we built a simple application that consisted of 118 lines of Python code hosted in the Google Application Engine cloud environment. The tool handled the IMS Basic LTI protocol and implemented the rules of the guessing game. The instructor could reset the game or view the results – the students could simply make a guess. The tool was then integrated into Sakai using IMS LTI and made available in the course site as shown in Figure 3.

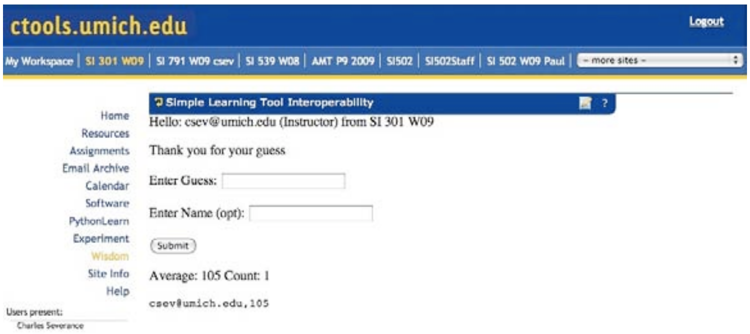

Figure 3. The Number Guessing Application Running in Sakai

The number guessing game was written in about two hours and used in lecture on the same day that it was written. After the game was used for one lecture, there were a few bugs that were found and fixed for use in later lectures. A tech-savvy instructor did the entire process with no impact on, nor involvement of, the enterprise Learning Management System. And since the tool was hosted for free on the Google Application Engine, the instructor did not even have to worry about the infrastructure needed to run the tool.

Another game was written to demonstrate the "Free Rider" problem which occurs when groups are sharing the costs of some shared common good and how people balance the overall group benefit against their own short-term potential for gain. The Free Rider Application had several features that made it very effective for in-class use. First, since the game enforced the rules, it was not necessary to teach anyone how to "run" the game. Also, the game picked five students to play the game automatically. Once the players were selected and the game started, the other students were given a display that updated dynamically as the game was played. So students could learn by playing the game and when they were not playing, they could watch as game masters. The students who were watching could see when players changed strategies and could see the game develop and see which strategies led to the largest payoff.

The games are very simple and easy to write – since they are embedded in a rich LMS, the tools only have to solve the very simple problem related to the lesson at hand. Once these tools are written and put up on Google Application Engine, they could be used by any instructor using the "Wisdom of Crowds" book in their classroom by simply exchanging the IMS Learning Tools Interoperability URL, Key, and Secret.

The number of teachers using "Wisdom of Crowds" in their classroom at any given moment or during any given semester is very small. But at the same time, the effort to develop and the tools is also very small. And the effort involved is small enough that a single teacher might do it simply for his or her own use. Following the example of free applications available in an "apps store" this instructor might also post it on a public site for any other instructor using Surowiecki's book in their course. This example is toward the far end of the long tail of teaching applications. However, even if it only affects 25 courses across the country in any semester, these tools can be designed to be really helpful for helping students to understand more deeply this material. One could imagine a future where books like "Wisdom of Crowds" might come with already-built games developed and provided by the author or publishers. These games would be ready to plug into the local enterprise LMS using IMS Learning Tools Interoperability.

Required LMS Features to Enable the Long Tail

If we are to address the need to build and use the long tail of learning tools, we must reduce the barriers to plugging new tools into Learning Management Systems. Opening up these system to outside applications ultimately puts the ability to "add a tool" in the hands of the instructors and allows them to add the new tools in a few clicks and with no intervention on the part of the technical support staff. Sakai is generally designed to give instructors a great deal of control of course content to the instructors. A Basic LTI tool has been developed for Sakai that allows the instructor to easily integrate externally provided tools into Sakai. The primary information needed for to integrate a tool using Basic LTI is a URL, Key, and Secret as shown in Figure 4.

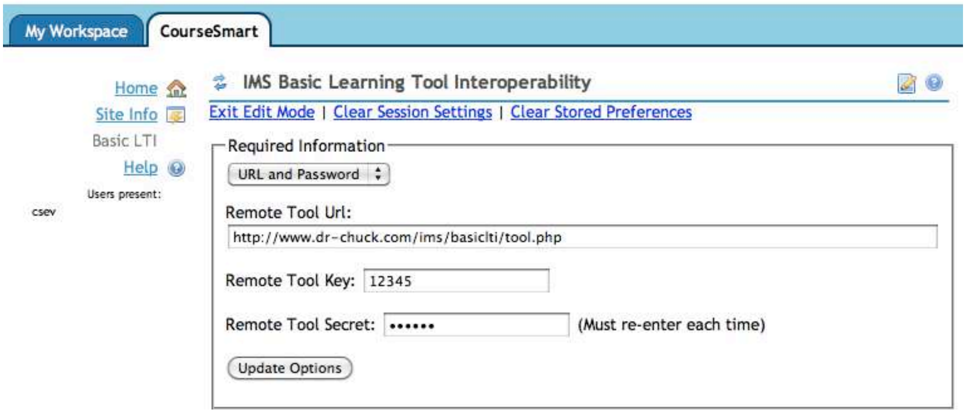

Figure 4. Setting the URL, Key, and Secret in the Sakai Basic LTI Tool

Since the IMS Basic LTI tool will send roster information to the externally provided tool, it is important to make sure that the instructor is aware that this is happening and approves the release of any identifying information using the configuration options shown in Figure 5.

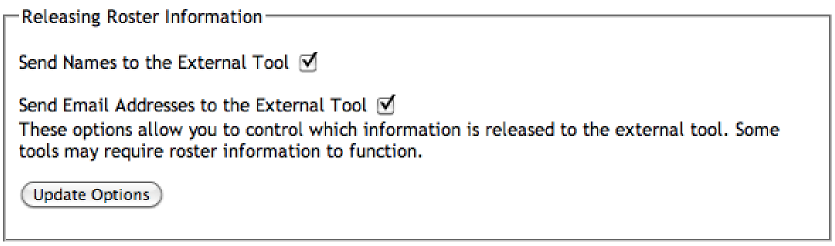

Figure 5. Privacy Controls in the Sakai Basic LTI Tool

The IMS Basic LTI specification makes any data that contains identifying information optional. The default in Sakai is not to send any identifying information so the teacher must explicitly agree to send the identifying information to the external tool.

The developers of each LMS will make their own choices about which aspects of LTI are placed in the hands of instructors and which aspects of configuration are only available to system administrators or technical support staff. The Sakai tool allows local customization of the configuration process for LTI, giving system administrators fine-grained access control over which features and capabilities are made available to the Instructors. This allows each institution to progress toward the model of many tools in the long tail at the pace that is comfortable and sustainable for their organization.

Conclusion

We present the case for adding more flexibility to Learning Management Systems and putting that flexibility in the hands of instructors. By making it possible to easily integrate more narrow and learning-centered tools into the LMS without requiring a change in production software or server reboot, we make it far more practical for teachers and students to experiment with new tools and to find the right set of tools for their particular course, supporting a move from accidental to intentional pedagogy (McGee, Carmean & Jafari, 2005). Once the barriers are removed from within the LMS, a market for these externally hosted tools can develop– particularly in the "middle tail" category where tools have broad applications within a narrow segment of the population. We would hope that many commercial and free tools would be developed and made easily available – resulting in many innovative experiments that can lead to a greatly improved learning experience for students of any age.

Once the barriers for implementation are reduced even further, we envision that tools will be written by teachers or students to solve very focused learning needs. As LMS evolve and interoperability standards improve, many of these tools will be very simple to develop and use because they will be placed in the rich context of a mainstream LMS.

Perhaps the most exciting aspect of enabling teachers to build, exchange, and use thousands or even hundreds of thousands of new tools is how we enable the exploring of an increasingly wide range of new ways to teach. In addition, by opening the enterprise LMSs to virtually unlimited expansion, we have a place to explore emerging approaches such as social learning and the increased use and remixing of content from Open Educational Resources in new and novel ways. In a sense, while we can see an immediate exciting future that this approach enables, the truly exciting innovations are those that we can't even imagine because we are locked into the content-delivery patterns of the current crop of enterprise LMS. Finally, by opening up these opportunities to instructors we simultaneously open them up for students to build, organize, and use tools for their own collaboration and learning purposes.

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