



By Brian Lamb

Dr. Mashup

or, Why Educators Should Learn to Stop Worrying and Love the Remix

A music track that lays a vocal from Madonna over guitars from the Sex Pistols. A classroom portal that presents automatically updated syndicated resources from the campus library, news sources, student events, weblogs, and podcasts and that was built quickly using free tools. A Web site that takes crime data from the Chicago Police and applies them to Google Maps, without being affiliated with either. Each of these is a product of the stunning growth in on-line materials available in reusable formats; each is energized by the character of digital culture; and each may be described as a *mashup*.

Brian Lamb is Manager of Emerging Technologies and Digital Content for The University of British Columbia's Office of Learning Technology and is a Research Fellow with Utah State University's Center for Open and Sustainable Learning. He posts ill-tempered ramblings on social learning, open education, and unrelated matters on his weblog Abject Learning (<http://weblogs.elearning.ubcc.ca/brian/>).



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As the term suggests, mashups involve the reuse, or remixing, of works of art, of content, and/or of data for purposes that usually were not intended or even imagined by the original creators. Although the historical roots of remix and mashup culture are deep, the properties of digital media are what have given ordinary individuals the power to reshape works on an unprecedented scale. In recent years, with the emergence of Web 2.0, the ability to copy, to combine, and to remix has been extended. Increasingly, it's not just works of art that are appropriated and remixed but the functionalities of online applications as well.

For educators and policy-makers, already struggling with the many cultural and logistical challenges posed by digital technologies, mashups complicate the picture even while offering tremendous promise. What, exactly, constitutes a valid, original work? What are the implications for how we assess and reward creativity? Can a college or university tap the same sources of innovative talent and energy as Google or Flickr? What are the risks of permitting or opening up to this activity?

A Note on Terminology

Oliver Paradis, writing in *Wired* magazine, recently complained: "The truth is, *mashup* is a manufactured buzzword, and like any buzzword, it drips with tacky artificiality, marketing innuendo, and vague implications. I have lately observed the application of this metaphor to the most unlikely subjects, including art, video, laptops, cell phones, movies, sneakers, cars, toothbrushes, and who knows what else. I look forward to the moment your writers properly address this particularly trendy and overused word by jettisoning it from your hallowed pages."¹

Without apologies, I am pleased to apply this "manufactured buzzword" to the subject of education as well. But for readers unfamiliar with the term, or ones confused by the indiscriminate usage

that Paradis justifiably complains about, I offer here some definitions. *Remix* is the reworking or adaptation of an existing work. The remix may be subtle, or it may completely redefine how the work comes across. It may add elements from other works, but generally efforts are focused on creating an alternate version of the original. A *mashup*, on the other hand, involves the combination of two or more works that may be very different from one another. In this article, I will apply these terms both to *content remixes* and *mashups*, which originated as a music form but now could describe the mixing of any number of digital media sources, and to *data mashups*, which combine the data and functionalities of two or more Web applications.

An Assault on Originality?

More than forty years ago, the Canadian pianist Glenn Gould wrote:

One of the certain effects of the electronic age is that it will forever change the values that we attach to art. In fact, the vocabulary of aesthetic criteria that has been developed since the Renaissance is mostly concerned with terms that are proving to have little validity for the examination of electronic culture. I refer to such terms as "imitation," "invention," and, above all, "originality," which in recent times have implicitly conveyed varying degrees of approval or censure, in accordance with the peculiarly distorted sense of historical progression that our age has accepted, but which are no longer capable of conveying the precise analytical concepts they once represented.

Electronic transmission has already inspired a new concept of multiple-authorship responsibility in which the specific concepts of the composer, the performer, and, indeed, the consumer overlap. . . . In fact, implicit in electronic culture is an acceptance of the

idea of multilevel participation in the creative process.²

Before we get too deep into the subject, we should address what is perhaps the core objection to derivative works—an objection suggested by how we think of the term *derivative*. It is common to assume that remakes or reworkings are inherently lesser forms of creation than something that is "original" and that free reuse somehow degrades the value of the source. Modern copyright law and the intense social stigma associated with a term such as *plagiarism* speak to such assumptions.

Questions of originality (origins of a work) are rarely clear-cut. In his recent *Harper's* article "The Ecstasy of Influence," the novelist Jonathan Lethem imaginatively reviews the history of appropriation and recasts it as essential to the act of creation.³ Lethem notes Muddy Waters's casual acknowledgment of Son House, Robert Johnson, and "the cotton field" as the genealogy of his song "Country Blues"—an example of the jazz and blues borrowing that Lethem likens to a form of open-source culture. He asserts that visual, sound, and text collage "might be called *the* art form of the twentieth century, never mind the twenty-first." And if these examples do not seem sufficient, "consider the remarkable series of 'plagiarisms' that links Ovid's 'Pyramus and Thisbe' with Shakespeare's *Romeo and Juliet* and Leonard Bernstein's *West Side Story*, or Shakespeare's description of Cleopatra, copied nearly verbatim from Plutarch's life of Mark Antony and also later nicked by T. S. Eliot for *The Waste Land*. If these are examples of plagiarism, then we want more plagiarism." Confronted with this reality, Lethem concludes: "Finding one's voice isn't just an emptying and purifying oneself of the words of others but an adopting and embracing of filiations, communities, and discourses."

Lethem's article is a must-read for anyone with an interest in the history of ideas, creativity, and intellectual property. It brilliantly synthesizes multiple disciplines and perspectives into a wonderfully readable and compelling argument. It is also, as the subtitle of his article acknowledges, "a plagiarism." Virtually every passage is a direct lift from another



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source, as the author explains in his “Key,” which gives the source for every line he “stole, warped, and cobbled together.” (He also revised “nearly every sentence” at least slightly.) Lethem’s ideas noted in the paragraph above were appropriated from Siva Vaidhyanathan, Craig Baldwin, Richard Posner, and George L. Dillon.

Elements of reuse have always been present in creative work, even though the borrowing may have been framed in terms of “tradition,” or “influence.” Artistic and scholarly works build on the work of others. Yet the technology developments of the past century have clearly corresponded with a new attitude toward the “aura” associated with a work of invention and with more aggressive attitudes toward appropriation. It’s no mere coincidence that the rise of modernist genres using collage techniques and more fragmented structures accompanied the emergence of photography and audio recording. Reading Walter Benjamin’s highly influential 1936 essay “The Work of Art in the Age of Mechanical Reproduction,”⁴ it’s clear that the profound effects of reproductive technology were obvious at that time. As Gould argued in 1964 (influenced by theorists such as Marshall McLuhan⁵), changes in how art is produced, distributed, and consumed in the electronic age have deep effects on the character of the art itself.

In the field of music, pioneers in the art of modern music remix had to use predigital technology, laboring to loop and splice tape or to manipulate vinyl records on turntables to create new sounds and styles. Without question, the rise of digital media has pushed the practice to new levels of activity and imagination. The ease of copying and manipulating digital media naturally supports the sampling and recombining of materials. Like participatory media genres such as blogging, media production tools have gotten cheaper and easier to use even as they have become more powerful. The

result has been a flood of work created by largely anonymous media artists who are reimagining the iconography of popular culture, unearthing forgotten artifacts and contextualizing them anew. One only has to spend an hour surfing YouTube.com to get a sense of the subversive fun being had by hundreds of thousands of culture mashers.⁶

Content Mashups: The Educational Remix

The preceding riff on remix culture is not meant to suggest that educators should abandon existing approaches for developing instructional content and concentrate their efforts on making YouTube videos that mash up old archival footage (though some are doing just that⁷). Although the wider Web culture has embraced a vision and practice of reuse that goes much further than common educational practice, even modest changes in attitudes and approaches may have significant effects.

The “remix” of digital content can happen in any number of ways. As Tony Hirst has argued: “The easiest remix is not really a remix at all, and barely counts as a reuse, though it is a *republish* or *represent*—just take a direct copy of someone else’s content and make it your own property/publish it on your own site, in your own content area . . . at least it shows someone else cares enough to take a copy. And it’s *another* place for eyeballs to see that content.”⁸ From there, one might delete or edit irrelevant references, add and update links, perhaps embed an appropriate online video, and link to a podcast. Maybe a dynamically updated RSS feed from a relevant blog or del.icio.us tag can be rendered on the sidebar to provide a steady stream of fresh content. Hey . . . now we’re mashing it up!

Educational technologists may wonder if *remix* or *content mashup* are just hipper-sounding versions of the learning objects vision that has absorbed so

much energy from so many talented people—with mostly disappointing results. As Susan Metros stated in a 2005 *EDUCAUSE Review* article: “Learning objects have not fulfilled their promise of transforming education.”⁹ Little has changed since then to contradict that assertion. The question is, why should a culture of remix take hold when the learning object economy never did? What’s the difference? I would argue that for one thing, the standards/practices relationship implicit in the learning objects model has been reversed. With only the noblest of intentions, proponents of learning objects (and I was one of them) went at the problem of promoting reuse by establishing an arduous and complex set of interoperability standards and then working to persuade others to adopt those standards. Educators were asked to take on complex and ill-defined tasks in exchange for an uncertain payoff. Not surprisingly, almost all of them passed.

Meanwhile, in the online world, millions of bloggers were gleefully sharing their materials and forming fluid communities of interest without central coordination or organizational incentives. The practices were easy to adopt, the benefits were immediate, and there was fun to be had. Relatively simple standards such as RSS enabled a great deal while requiring very little.¹⁰ Around the same time that the statement “users will never add metadata” was becoming a mantra at gatherings of increasingly frustrated learning object promoters (again, I was often present) and when most learning object repositories were floundering, resource-sharing services such as del.icio.us and Flickr were enjoying phenomenal growth, with their user communities eagerly contributing heaps of useful metadata via simple folksonomy-oriented tagging systems.

Although the disappointing impact of the learning objects approach is easy to criticize, Web 2.0 remix won’t be any more significant on campus unless certain conditions are met:

- *Open and Discoverable Resources.* Internet users enjoy a wealth of available resources from a vast range of sources. In addition to the surprising effectiveness of free text searching in Google,



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emergent communities provide a steady stream of socially filtered and recommended materials via blogs, social bookmarking tools, and networking nodes such as Twitter. Whatever one thinks of *Wikipedia's* epistemic legitimacy, it is an astonishing resource that provides an excellent starting point for research on almost any subject. Essential to the circulation of all these sources is that they are readily found on the open net and can be linked to directly. Educators might justifiably argue that their materials are more authoritative, reliable, and instructionally sound than those found on the wider Web, but those materials are effectively rendered invisible and inaccessible if they are locked inside course management systems.

- **Open and Transparent Licensing.** Having access to a wealth of resources is tantalizing, but this access is pointless if the materials cannot be reused. Copyright clearance is complex, time-consuming, and often expensive. It's a dirty but open secret that many courses in private environments use copyrighted third-party materials in a way that pushes the limits of fair use—third-party IP is a big reason why many courses cannot easily be made open. Content creators working in educational institutions may be willing to share their work, but they rightfully worry about receiving attribution, about undesirable commercial exploitation, and/or about inappropriate modifications to their work. Creative Commons, or CC (<http://www.creativecommons.org>), is the best-known framework providing a middle ground between restrictive copyright and the public domain. Designating a CC license is easy, and applying it to a digital work essentially tells the world: "Reuse my stuff, just give me credit." The arduous process of gaining permis-

sion is avoided, and the attribution requirement can usually be met with a simple hyperlink. Finding a CC-licensed image from the open Web is enabled by Flickr's advanced search (<http://www.flickr.com/search/advanced/>), which allows for searching across the popular photo-sharing site's vast archive of CC-licensed images (more than 36 million available as I write this¹¹). Likewise, Yahoo allows for searching across the Web for CC-licensed materials in various formats (<http://search.yahoo.com/cc>).

- **Open and Remixable Formats:** In order for educators to reuse other educators' materials, they need to be able to customize or adapt the materials—maybe because they need to make a resource more applicable to their local context or maybe because they have a new idea, one that the original creators never imagined.¹² Part of making a resource reusable involves making the right choices for file formats. Although the MP3 is not an open format, it is widely used, can be listened to on millions of computer players across platforms and on portable music players, and is easy to manipulate or edit. A streaming audio file in a proprietary format, on the other hand, can be listened to only on a computer with a live Internet connection and cannot be edited unless the file is "ripped" (or "liberated," depending on your point of view). To facilitate the remixing of materials, educators may want to consider making the source files that were used to create a piece of multimedia available along with the finished result. The musicians David Byrne and Brian Eno took this step in April 2006, offering online access to all of the multitracks to two songs when they released a new version of their 1981 album *My Life in the Bush of Ghosts* (<http://bushofghosts.wmg.com/>). In addition to choosing the right file format and perhaps offering

the original sources, another issue to consider when publishing content online is the critical question: "Is there an RSS feed available?" If so, conversion tools such as Feed2JS (<http://www.feed2js.org>) allow for the republication of RSS-ified content in any HTML Web environment, including a course management system, simply by copying and pasting a few lines of JavaScript code. When an original source syndicated with RSS is updated, that update is automatically rendered anywhere it has been republished. Free online portal services like Netvibes (<http://www.netvibes.com/>) can also render RSS feeds from diverse sources such as blogs, news services, library catalogs, campus information from student services (such as job postings), podcasts, and much more on a single, easily assembled and used dynamic resource page. Pageflakes (<http://www.pageflakes.com/>), another RSS-based personal portal, supports a number of education-specific templates for tracking grades and displaying class schedules along with resources; pages with such sensitive information can also be made private.¹³ Grazr (<http://grazr.com/>) is an RSS tool that allows users to embed a structured feed aggregator and reader widget in any Web environment.

The potential payoff for using open and discoverable resources, open and transparent licensing, and open and remixable formats is huge: more reuse means that more dynamic content is being produced more economically, even if the reuse happens only within an organization. And when remixing happens in a social context on the open Web, people learn from each other's process.

Data Mashups: Remixing Functionality
As noted earlier, the term *data mashup* describes a Web site or application that combines the data and functionality of multiple Web sites into an integrated experience. The first Web site to open my eyes to the potential of this form of mashup was HousingMaps (<http://www.housingmaps.com>), which takes the free classified ads for housing



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vacancies on craigslist and locates them on the appropriate map from Google Maps. But a disclaimer printed at the top right of the page acknowledges, "This site is in no way affiliated with craigslist or Google." Paul Rademacher was able to combine the functionalities of the source sites because both exposed key pieces of data and function via their application programming interfaces (APIs).

For those of us who avoid code system architecture whenever possible, the concept of the API can be tricky. Jack Schofield, in an accessible treatment of the subject written for the *Guardian Unlimited*, takes the concept of mashups back to their musical roots by way of comparison: "An API provides an interface and a set of rules that make it much easier to extract data from a website. It's a bit like a record company releasing the vocals, guitars and drums as separate tracks, so you would not have to use digital processing to extract the parts you wanted."¹⁴ Designers decide which functions or data they will expose to others, and under what conditions. They may make the API public, require registration and account approval, or license access only to customers or partners.

What's new about mashed-up application development? In a sense, the factors that have promoted this approach are the same ones that have changed so much else about Web culture in recent years. Essential hardware and software has gotten more powerful and for the most part cheaper, while access to high-speed connectivity and the enhanced quality of online applications like Google Docs have improved to the point that Tim O'Reilly and others can talk of "the emergent Internet operating system."¹⁵ The growth of user-centered technologies such as blogs have fostered a DIY ("do it yourself") culture that increasingly sees online interaction as something that can be personalized and adapted on the individual level. As described earlier, light syndi-

cation and service models such as RSS have made it easier and faster than ever to create simple integrations of diverse media types. David Berlind, executive editor of *ZDNet*, explains: "With mashups, fewer technical skills are needed to become a developer than ever. Not only that, the simplest ones can be done in 10 or 15 minutes. Before, you had to be a pretty decent code jockey with languages like C++ or Visual Basic to turn your creativity into innovation. With mashups, much the same way blogging systems put Web publishing into the hands of millions of ordinary non-technical people, the barrier to developing applications and turning creativity into innovation is so low that there's a vacuum into which an entire new class of developers will be sucked."¹⁶

Perhaps no single development illustrates the increasing simplicity of mashup programming more dramatically than the introduction of Yahoo!'s Pipes service (<http://pipes.yahoo.com/>). Described by O'Reilly as "a milestone in the history of the internet,"¹⁷ the Pipes interface is a remarkably intuitive drag-and-drop editor that allows the user to bring in resources from Google, Flickr, and other data sources, manipulate the resources, and generate outputs that can be implemented in most Web environments. Although the service has not reached a level of simplicity approaching that of blogs (the developers of Pipes have noted that the service is presently targeted at the "top 10% of the market," from developers to remixers¹⁸), browsing the creations of Pipes users quickly illustrates the potential power of this approach. The ability to "clone" other users' mashups is especially exciting: a newcomer does not need to spend time learning how to structure the data flows but can simply copy an existing framework that looks useful and then make minor modifications to customize the result.¹⁹

Educators have begun to exploit this potential. Tony Hirst, from the United

Kingdom's Open University, has documented his ongoing experiments with Pipes and other mashed-up approaches to educational content on his blog *OUseful Info*. Among Hirst's products is a "deliSearch Pipe," which allows users to run a constrained Internet search over domains that have been flagged by a user of the del.icio.us social bookmarking service. Another Pipe that Hirst has created is the "OpenLearn Unit Outlinks Search Hub Pipe," which extracts "all the outgoing links from a course unit, then feeds these into a Yahoo Search pipe, which uses the domains as search limits for the search."²⁰ In other words, this Pipe can create a filtered search of trusted domains that are relevant to a particular course, and the filtered search will adjust automatically as new links are added to the course materials. Of course, this added functionality requires open content and a reusable data format in order to work properly. If the course unit in question is locked away in a course management system behind a password firewall, Pipes cannot access the data required to create the customized search. As with content remixing, open access to materials is not just a matter of some charitable impulse to share knowledge with the world; it is a core requirement for participating in some of the most exciting and innovative activity on the Web.

Another common cross-application functionality focuses on integrating maps with other tools. This is usually accomplished via "geotagging," the process of adding geographical identification metadata, such as latitude and longitude, to Web sites, RSS feeds, or images. Ewan McIntosh describes how this practice could enhance a school's field trip: "The Shropshire students could go out on the trail of Roman ruins and artefacts, photographing and Flickr'ing their findings. Their Flickr photos would also carry a precise geotag . . . , showing exactly the point where that photo was taken. This could be done using GPS tools in the field, or done afterwards by finding the location on Google Maps manually and finding out the longitude and latitude from that page. . . . Working with the Scottish students they could then find out the stories behind these artefacts and create a Google Map which tracks



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these stories geographically, historically and anecdotally.²¹

Since McIntosh laid out that scenario, Google has introduced its "My Maps" functionality,²² which simplifies the process of creating multimedia annotated maps and incorporates user-generated resources into Google Maps searches. With this shift, Google essentially brings into its primary site many of the functionalities that had been added by nonaffiliated programmers via its API. The work and activity of these programmers undoubtedly informed Google as it built out its service. Essentially, these mashup developers were performing free research and development and prototyping on Google's behalf, even as they created services that expanded Google's reach. For those still wondering what the value proposition is for offering an open API, Google's development process offers a compelling example of the potential rewards.

The notion of the open API is a core strategy for Web 2.0 companies. Offering a sense of how pervasive this approach is and how it is manifesting itself, ProgrammableWeb.com (<http://www.programmableweb.com>) tracks available APIs (431 in early May 2007) and shows how they are being applied across the Web. Yet for the most part, the notion of the data mashup and the required openness is not even a consideration in discussions of technology strategy in higher educational institutions. "Data integration" across campus systems is something that is handled by highly skilled professionals at highly skilled prices. Libraries have begun to explore the possibilities of data mashups: Jon Udell's LibraryLookUp bookmarklet, which allows users to see if a book found on a site such as Amazon.com is available in their local library, and the entries to the Mashing Up the Library competition demonstrate real promise.²³ Elsewhere, it is difficult to point to significant activity suggesting that the mashup ethos is taking hold in academia the way it is on the wider Web.

Revealing how a more adventurous and inclusive online development strategy might look on campus, Raymond Yee recently posted a comprehensive proposal for his university (UC Berkeley), in which he outlined a "technology platform" not unlike the one employed by Amazon.com (<http://aws.amazon.com/>)—resources and access that would be invaluable for the institution's programmers as well as for outside interests to build complementary services. Yee articulated a vision that carries immense pedagogical, along with obvious practical, benefits: "We should invite students to be active co-developers, to use our web services and show us, what can be done with them. If we are doing things right, we will be surprised by how people will use it. Several years ago, I hired a student who made a name for himself in web scraping the Berkeley course catalog system to create an alternative and reportedly superior, interface. Ideally, we can create our systems so that student[s] should not have to web-scrape our systems, but have an API to access the data and wrap their own interface."²⁴

All too often, college and university administrators react to this type of innovation with suspicion and outright hostility rather than cooperation. Witness the recent case at Harvard, where students, frustrated with the quality of the official institutional Web portal, decided to build their own portal, entitled Crimson Connect (<http://www.crimsonconnect.com/>), using RSS feeds and, for the most part, existing free software tools. University officials responded by demanding the removal of material that had been syndicated from password-protected course pages.²⁵

Moving toward the Mashup

Educators and higher education decision-makers have an obligation to carefully and critically assess new technologies before making radical changes. Taking a

more freewheeling approach to content reuse and making campus technologies more accessible to data mashups require significant changes in existing practices and attitudes. These changes won't happen quickly or easily. But those of us in higher education who observe the successful practices in the wider Web world have an obligation to consider and discuss how we might apply these lessons in our own contexts. We might ask if the content we presently lock down could be made public with a license specifying reasonable terms for reuse. When choosing a content management system, we might consider how well it supports RSS syndication. In an excellent article in the March/April 2007 issue of *EDUCAUSE Review*, Joanne Berg, Lori Berquam, and Kathy Christoph listed a number of campus activities that could benefit from engaging social networking technologies.²⁶ What might happen if we allow our campus innovators to integrate their practices in these areas in the same way that social networking application developers are already integrating theirs? What is the mission-critical data we cannot expose, and what can we expose with minimal risk? And if the notion of making data public seems too radical a step, can APIs be exposed to selected audiences, such as on-campus developers or consortia partners? However educators choose to respond, and whatever educators think of the term *mashup*, the complex relationships between individuals, organizations, content, data, and applications will never be the same. *e*

A short mashed-up audio complement to this article can be downloaded (along with most of the track's sources) at <<http://www.educause.edu/ir/library/multimedia/erm0704a.mp3>>.

Notes

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2. Glenn Gould, "Strauss and the Electronic Future" (1964), in *The Glenn Gould Reader*, ed. Tim Page (New York: Knopf, 1984), 92.
3. Jonathan Lethem, "The Ecstasy of Influence," *Harper's Magazine*, February 2007, <<http://www.harpers.org/archive/2007/02/0081387>>.
4. Walter Benjamin, "The Work of Art in the Age of Mechanical Reproduction" (1936), available online: <<http://web.bentley.edu/empl/c/>>

- rcrooks/toolbox/common_knowledge/general_communication/benjamin.html>.
5. Gould would later write, when interviewing himself: "The 'creative audience' concept to which you've devoted a lot of interview space elsewhere offers a kind of McLuhanesque fascination" ("Glenn Gould Interviews Glenn Gould about Glenn Gould," *High Fidelity*, February 1974, <<http://www.collectionscanada.ca/glenn Gould/028010-5027-e.html>>).
 6. Two of my favorite YouTube clips are the remix of *The Shining's* trailer (<http://www.youtube.com/watch?v=iVjl7gK4HGUG>) and the mashup of the original *Star Trek* TV series with a Monty Python song (http://www.youtube.com/watch?v=eEnyT0_BjxA). These two videos themselves illustrate the difference between a *remix* and a *mashup*.
 7. For one example, see David Wiley's account at <<http://opencontent.org/blog/archives/312>>.
 8. Presumably this would be done with attribution to the original content creator. See Tony Hirst, "So What Exactly Is an OpenLearn Content Remix?" *OUseful Info*, April 3, 2007, <<http://blogs.open.ac.uk/Maths/ajh59/010112.html>>.
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 10. "Enable, Don't Require" is one of Stephen Downes's "Design Principles for a Distributed Learning Object Repository Network," *Learning Place*, November 2002, <<http://education.qld.gov.au/learningplace/onlinelearning/courses/sdownesnov.html>>.
 11. See <<http://www.flickr.com/creativecommons/>>.
 12. For more on the importance of "localizing" educational resources, see David Wiley, "Thoughts from the Hewlett Open Ed Grantees Meeting," *Iterating toward Openness*, September 27, 2005, <<http://opencontent.org/blog/archives/192>>.
 13. See Will Richardson, "Using Pageflakes as Student Portal," *weblogg-ed*, November 21, 2006, <<http://weblogg-ed.com/2006/using-pageflakes-as-student-portal/>> and his sample page at <<http://www.pageflakes.com/weblogged.ashx?page=4949669>>.
 14. Jack Schofield, "It's All in the Mix," *Guardian Unlimited*, February 2, 2006, <<http://technology.guardian.co.uk/weekly/story/0,,1699502,00.html>>.
 15. Tim O'Reilly, "Inventing the Future," *O'Reilly Network*, April 9, 2002, <<http://www.oreillynet.com/pub/a/network/2002/04/09/future.html>>.
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 17. Tim O'Reilly, "Pipes and Filters for the Internet," *O'Reilly Radar*, February 7, 2007, <http://radar.oreilly.com/archives/2007/02/pipes_and_filters.html>.
 18. Dion Almaer, "Pipes: A Tech Talk," *Ajaxian*, April 4, 2007, <<http://ajaxian.com/archives/pipes-a-tech-talk>>.
 19. Within weeks of the submission of the draft of this article, new creation tools for data mashups were launched by Microsoft (<http://www.popfly.ms/>) and Google (<http://googlemashups.com/>). See Jay Neely, "More Signal, Less Noise: The Power of RSS Mashups," June 2, 2007, *Social Strategist*, <<http://socialstrategist.com/2007/06/02/more-signal-less-noise-the-power-of-rss-mashups>>.
 20. See Tony Hirst's relevant blog posts for more context: <<http://blogs.open.ac.uk/Maths/ajh59/009301.html>>; <<http://blogs.open.ac.uk/Maths/ajh59/010193.html>>.
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