In this issue:

From Computer Literacy to Web 2.0 Literacy: Teaching and Learning Information Technology Concepts Using Web 2.0 Tools

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Abstract

Computer literacy has evolved from writing simple BASIC programs to using desktop productivity applications. The shift from mainframe to personal computer brought about the need to rethink computer literacy courses to introduce basic skills and familiarity using desktop productivity applications. While these skills remain important, the recent shift of applications and data from the desktop to the Web has brought about another stage in the evolution of computer literacy education to the extent that today's students not only need to be "computer literate" but also "Web literate" or "Web 2.0 literate." Computer literacy courses retained the old concepts, but had less time to cover them because of the need to introduce new concepts. This paper examines approaches to teaching first year college introductory technology courses and suggests practical exercises and skills required for today's students to be Web 2.0 literate.

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1. INTRODUCTION

The idea of computer literacy began with John Kemeny and Thomas Kurtz who developed the Dartmouth time-sharing system and the BASIC programming language in 1964. Kemeny and Kurtz were motivated by their conviction that

> knowledge about computers and computing must become an essential part of a liberal education. Science and engineering students obviously need to know about computing in order to carry out their work. But, we felt exposure to computing and its practice, its powers and limitations must also be extended to non science students, many of whom will later be in decision-making roles in business, industry and government. (Kemeny & Kurtz, 1968)

From the start, Kemeny and Kurtz emphasized both job skills and the concepts necessary to be an effective citizen. The skill component of the first generation computer literacy courses stressed algorithmic thinking using BASIC (and later Pascal) and the concepts focused on hardware, software, applications, and social implications of computers. With the advent of the personal computer in the 1980's, programming skill was dropped for skill with personal computer productivity software, mainly word processing and spreadsheets, and personal computer operating systems.

With the advent of the Internet, email and Web surfing skills were added to the course.

While some of the classic concepts were retained, new skills left less time for them.

Students Today

The Internet has emerged as an important platform for developing and delivering applications and today's students have been using it since they were children. (Prensky, 2001; Palfrey and Gasser, 2008). They are familiar with email, text messaging, searching the Web, using MP3 players, and productivity software, but may not have a grasp of the underlying technology that makes them possible. They browse the Web, but do so without understanding that there are multiple Web servers on the Internet and that "Internet" and "Web" do not mean the same thing. They can email photos, but have no idea why they are so big and why it takes such a long time to download them. They are often both inefficient users and poorly prepared for making business and application decisions. This can lead to a feeling of intimidation and alienation (Illich, 1973) as users of technology.

Many students barely remember the Web's early days, when the experience of browsing the Web was slow, simple, and one-sided. Sites with which they interact the most – Facebook, Wikipedia, Flickr, My-Space, and YouTube – are fast, slick, and interactive. These sites characterize the genre of Web applications that have become known as Web 2.0. (O'Reilly, What Is Web 2.0: Design Patterns and Business Models for the Next Generation of Software, 2005). Characteristic of Web 2.0 applications are that they "harness network effects to get better the more people use them." (O'Reilly, Web 2.0 Compact Definition: Trying Again, 2006).

Guiding Questions

O'Reilly's proposal that technology enables new models for business and social interaction on the Internet identifies a new literacy that today's students must have.

Thus two guiding questions for this paper emerge:

- What concepts, skills, and applications must one know to be "Web 2.0 literate?"

- How can these be taught in ways that also introduce or reinforce information technology concepts found in "traditional" introductory IT courses?

2. TEACHING COMPUTER LITERACY

The literature suggests that there are two common approaches to updating the curriculum to include Web 2.0 topics: integrating the use of Web 2.0 tools in courses throughout the curriculum or including them in an introductory information technology course to be taken early on. Introductory courses focus on tools or are often organized around real-world exercises that use the tools to illustrate applications and skills and concepts. This paper argues for the latter approach. The authors describe their stand-alone introductory IT courses to illustrate Web 2.0 concepts using real-world examples.

Many spread Web 2.0 tools throughout the curriculum. Several instructors (Cubric, 2007; Davi, Frydenberg, & Gulati, 2007) have made use of blogs or wikis in courses throughout the curriculum as a tool for promoting learning or for continuing class discussions outside of the classroom. In a "tools approach" to Web 2.0 literacy, Benziger (2006) suggests a series of Web 2.0 sites that if students master, can say they are "literate."

One of the main challenges in teaching Web 2.0 concepts in the classroom is creating realistic activities that will engage students as they learn about these technologies. Anderson suggests that the participatory nature of the Web 2.0 culture motivates students to learn, and that "the process of learning [will be] more compelling when they are producers as much as consumers" while others argue that Web 2.0 technologies in the classroom are nothing more than a fad that will "lose their initial attraction" after becoming fully integrated in the classroom (Anderson, 2007, p. 32).

3. USING WEB 2.0 TOOLS TO TEACH IT CONCEPTS

We are in a period of transition, during which incoming students arrive on campus with varying computer and Internet experience. To address the needs of the cohort of students with previous computer experience, the authors have each developed a new introductory IT course.

Concepts and Skills for a Web 2.0 World

IT 101 is offered as a "Technology Intensive" alternative to the traditional introductory IT course at Bentley University, a New England business university. The course introduces IT topics "through the lens of Web 2.0." See http://www.screencast.com/t/GcMea6VP for a video tour of the IT101 class wiki and how students use it to contribute to the class process throughout the semester. The instructor's web site (Frydenberg, 2009) contains links to the syllabus and course podcasts. This experimental course was offered for four consecutive semesters in this format, beginning in Fall, 2007.

CIS 275, Introduction to Network Applications, a course on the applications, implications and technology of the Internet for individuals and organizations, is offered at a state university in California. Students in this class have completed a traditional one-semester computer literacy course that focuses on the use of productivity applications, and most are planning to concentrate in CIS. See http://tinyurl.com/dy74wb for notes and assignments used in CIS 275 and a follow on course, CIS 471 and see http://cis471.blogspot.com/ for a blog on current developments relevant to the course. These courses have been offered since 2005.

Both courses cover standard topics in introductory computing: using the World Wide Web, Computer components, HTML and Web pages, operating systems, FTP, image and video formats, wireless networking, and network applications. IT 101 also includes a unit on creating spreadsheets with Excel. CS 471 includes a unit on network applications and application development strategies. Both courses introduce Web 2.0 topics and concepts such as social networking, client/server architecture, RSS, blogs, wikis, social bookmarking, ranking, and mashups.

The authors see their courses as evolving prototypes for tomorrow's Introduction to Information Technology course. This paper presents exercises taken from IT 101, an introductory IT course, and CIS 275, a second-year networking applications course, that use Web 2.0 applications to illustrate IT concepts.

The paper uses these course designations to indicate the course in which each exercise was introduced.

Integrating the use of several technologies into a single assignment gives students a sense of their real world applications. These exercises emphasize the use of Web 2.0 tools in facilitating group work, enabling students to be active classroom contributors.

Exercises are grouped as primarily illustrating fundamental Web 2.0 Principles, introducing the Web as a platform for applications, and using the Web to collaborate and communicate.

Appendix 2 contains a matrix of concepts and corresponding Web 2.0 tools and technologies used to illustrate them. Readers are invited to add their own technologies to the list in the Google Spreadsheet at from which this list originates. (See http://tinyurl.com/yja8vut)

4. TEACHING FUNDAMENTAL WEB 2.0 PRINCIPLES

Table 1 shows skills and concepts associated with four exercises that illustrate fundamental Web 2.0 principles.

Blogs and Wikis Exercise

Web logs ("blogs") and wikis are Web 2.0 tools for publishing and sharing information via a Web site. The instructor demonstrates the use of both at the first meeting. Students create their own blogs (at blogger.com) and then edit a class wiki page to add hyperlinks to their blogs. An informal poll at the start of the first class shows that most students have heard of a wiki (through Wikipedia) but have not edited or contributed to one. Wikis are useful in the classroom as tools for managing group projects, creating collaborative study sheets or class notes, facilitating group projects, and allowing students to share resources with their classmates (Frydenberg, 2008).

Involving students in both of these technologies quickly shows how easy blogs and wikis are to use, and how blogs and wikis are different. Students also experience being locked out of a wiki page when someone else is editing it, and can view the history of the page to see how a wiki tracks all previous changes.

Table 1. Fundamental Web 2.0 Principles

Exercise	Concepts	Skills
Blogs and Wikis	Data in the Cloud Synchronous vs. asynchronous collaboration Syndication Separate data from presentation	Create and configure a blog Comment on a blog post Contribute to a wiki
RSS and Syndication	RSS Feeds, Podcasts Aggregators XML Publish/subscribe	Identify and subscribe to RSS Feeds Recognize parts of an XML document for an RSS feed
Tagging and Social Bookmarking	Wisdom of Crowds (Massive asynchronous collaboration) Folksonomy Reusable components Social Networks Compare human-categorized information with search engine results	Upload pictures to Flickr Tag articles on Delicious Rank stories on Digg Create a tag cloud Embed content from one Web site or application on another
Rich User Experience	Identify features of "Web 2.0" applications Formats for audio, video, multimedia Presentation technologies	Evaluate software applications and features Take screenshots for use in Web site or presentations Capture, Edit, Compress, Post Video Upload PowerPoint presentation to SlideShare.net Include "embed" HTML code from another Web application in a blog

RSS and Syndication Exercise

RSS (Really Simple Syndication) is an XML-based technology that facilitates the process of monitoring multiple sources of news and information. Information providers make content available through RSS feeds (a structured flow of information) that specialized aggregator programs monitor for when users subscribe to them. Feed readers regularly check a user's subscriptions and download any new content. This makes RSS feeds popular to consume on both computing and mobile platforms.

Since students have created blogs already, they first examine their RSS feeds, and later discover other RSS feeds showing their own actions on the Web: every time they post a new photograph to Flickr, tag a new resource on Delicious, or post a message on Twitter.

Their assignment is to locate and subscribe to several RSS feeds on topics of personal interest, using feed reader (also called an aggregator) such as Google. They also display the contents of the feed in a gadget in the sidebar of a blog or Website, and view the feed in an RSS application on their cell phones.

This exercise gives a firm grasp of what XML "looks like" because the RSS feed is represented using XML, the language of sharing data between different applications on the Web. By subscribing to the same RSS feed using different readers, or on their cell phones, students intuitively learn the difference between data and how it is presented on many platforms.

Tagging and Social Bookmarking Exercise

Tagging and the ability to organize and retrieve information using an ad hoc classification known as a folksonomy is a fundamental Web 2.0 concept. In addition to social book marking applications like Delicious.com, tags are used on Flickr (for photo sharing), Technorati (for indexing blogs), Google Blog Search, and other sites.

Abbit investigated the impact of social content sites and found that social content sites were new to most students (Abbitt, 2007). Many felt that using them helped to find resources that would be useful later in their careers.

IT 101 students use Delicious for two weeks assigning tags to interesting sites that they visit during that time. They also use Delicious as a search tool, comparing the results with Google.

After tagging articles related to interests and favorite activities regularly on Delicious.com for even a short time, students generate tag clouds and sometimes notice that their tag clouds reveals information about themselves in ways that might otherwise not be so easy to discern. Students are empowered when they can organize information in ways that make sense to them.

Web 2.0 Features Exercise

After discussing O'Reilly's characterization of Web 2.0 applications (O'Reilly, What Is Web 2.0: Design Patterns and Business Models for the Next Generation of Software, 2005) and watching the YouTube video The Machine is Us/ing Us (Wesch, 2007), students work in small groups to find, evaluate, present, and demonstrate a new Web 2.0 application to their classmates.

Their presentations include an analysis of what the application is or does, who publishes it, how the company makes money, and which of its features make it Web 2.0.

IT 101 students create videos of their presentations, edit them, adding titles and credits, before posting to YouTube, and embedding the video on a class blog, for classmates to view and comment.

This assignment has several pedagogical benefits. It is collaborative; they must evaluate an application well enough to demonstrate, comment on, and suggest improvements for it; and they have to apply their understanding of a general model (O'Reilly's Web 2.0 characteristics) to a specific case. Students demonstrate their mastery of several technical skills in order to post their videos online.

5. TEACHING THE WEB AS A PLATFORM FOR APPLICATION DEVELOPMENT

A second set of exercises introduces the Web as a platform for creating and using applications. Table 2 summarizes these exercises, concepts, and skills.

Table 2. Introducing the Web as a Platform for Applications.

Exercise	Concepts	Skills
Ad-hoc application development	Abstraction, Software as a service Reduced skill and effort on Web-based development platforms Data and applications stored in the cloud Three-tiered applications	Create, navigate, and share a Google spreadsheet develop a simple database application using Zoho Creator Import and export data in different formats Embed a data view on a blog or Web site
Cloud Computing	Spreadsheet concepts Data and applications stored in the cloud Separate data from presentation Synchronous vs. asynchronous collaboration Application Programming Interfaces (APIs)	Compare applications that live "in the cloud" vs. "on the desktop Invoke an API to obtain data from the Web to place in a spreadsheet Build a simple mashup

Ad-hoc application development Exercise

In the 1980s, Apple II computers began infiltrating organizations. With an Apple II running the VisiCalc spreadsheet program, non-programmers could develop useful applications – time tracking and billing, accounting applications, financial forecasting, statistical analysis, etc. The spreadsheet lowered the bar for the time and skill needed to develop meaningful applications. Business units were able to build applications and maintain data files without the help or approval of the central IT department.

The same is happening today as the Internet becomes an important platform for developing and delivering applications. The Internet

has lowered the bar further, enabling users to develop a wide range of applications. A group of non-programmers beginning a project can easily establish a blog for progress reports, or start a wiki for developing documentation.

To illustrate the growing ease of developing ad-hoc applications, the CIS 275 instructor demonstrates a simple roster application implemented using a custom Active Server Pages (ASP) Web application, using a Google Spreadsheet, and using the Zoho Creator database service.

Students enter their names using each version of the application, and compare them, to discover their different features. The Google spreadsheet and the ASP Web application are roughly equivalent – the user may add or delete a record and list the current roster. The Zoho Creator version can add, edit and delete records as well as filter, search, sort, rearrange, embed, and export the data. (See Figure 1.)

Next they consider the time and skill level needed to develop the application. The spreadsheet is easiest since students are familiar with Excel and basic spreadsheet concepts. Building the online version is a bit slower than with a standalone spreadsheet program, but they are able to do it without further training.

The Zoho Creator version requires understanding of basic database concepts like table, row, column, and data type. Students with previous Access experience transfer the concepts used there to Zoho Creator. Building the application requires more time and skill than building the spreadsheet version, but most students learn Zoho Creator and build the application in less than two hours.

Implementation of the custom Web application requires programming skill and knowledge of HTML, ASP, SQL, and Visual BASIC. The application involves designing four screens (the roster listing, an input form, a delete-confirmation screen and an error message for an incomplete input form). The programmer must also plan the transitions between them, and write five executable scripts (initialize the database connection, list the roster, add a record, confirm delete request, and delete a record). All together, the application requires159 lines of code and comments. (See Figure 2.)

This exercise demonstrates that a non-technical user can build a full-featured roster application using a Web-based service much faster than a professional programmer can build a scaled down application.

Internet services can make developing an application much easier than custom programming. As service levels of abstraction rise, it is feasible for non-programmers to develop meaningful applications quickly.

Adding an RSS feed to the Zoho Creator application illustrates that an RSS feed can publish any stream event – a database change in this case – not only blog or podcast posts.

This is also a good module for discussing the pros and cons of using a service in an important application, and issues such as customization, service level agreements, and the possibility that the service provider might one day change their pricing or even go out of business.

The student learns to create, navigate and share a Google Spreadsheet and to develop a simple database application using Zoho Creator. They also see the process involved in creating a roster and data entry form "by hand" using ASP.

Cloud Computing Exercise

Cloud computing refers to data and applications that live within "the cloud" of the Internet. To further illustrate the idea of applications in the cloud, students compare Microsoft Excel, a desktop application, with Google spreadsheets. At the most basic level, students see the essence of spreadsheet applications (cells, formulas, referencing, functions, charts) despite user interface differences. Students become familiar with Google spreadsheets after having learned Excel and try to find features in one application that may not be found in the other.

Some students comment on the smaller number of features in the online application than in its desktop counterpart, or that it may run slower because it is operates over the Internet.

In addition to users collaborating with each other online, IT 101 students learn that it is also possible for the spreadsheet application itself to collaborate and make use of information provided by other Web applications,

a capability not as easily accomplished with a desktop spreadsheet application such as Excel.　Google Spreadsheets implements functions such as GoogleLookup() to access the results of Google searches, and Import-Feed() to import RSS feed data into a Google spreadsheet. Google's Sets technology finds items related to a particular value: by providing the value "George Washington", and holding the CTRL key (on a PC, or ALT on a Mac) while clicking and dragging on the small box in the lower right corner of the cells, Google Sets finds the names of several famous 17th Century Americans.　The formula in cell A2, =GoogleLookup(B2, "place of birth") finds the birth place of the value in B2. When copied down the column, Google Spreadsheets invokes the formula to find the birth place of each person in column B. The application displays the word Loading to indicate that it is accessing the information from the World Wide Web, and shows a hyperlink to the site from which the information was obtained. The exercise concludes by plotting the birth places with the corresponding names on a map embedded in the spreadsheet. (See Figure 3.)

This exercise introduces several key Web 2.0 concepts. Students recognize the difference between a desktop application and a rich Internet application within a browser, and understand the difference between documents that live on a desktop and "in the cloud." Using Google Sets and the Google Look-up functions provides a tangible way to introduce the notions of application programming interfaces (APIs) and Web services, and how they obtain data from remote sources to include in another Web application. Plotting the spreadsheet data on the map allows students to create a simple mashup, a Web 2.0 "hybrid" application that combines data from different sources.

6. TEACHING THE WEB AS A PLATFORM FOR COMMUNICATION AND COLLABORATION

The last set of exercises introduces the Web as a platform for communication through voice, video, text, and shared experience.

Online Class Meeting Exercise

Many of the exercises described here differentiate between synchronous and asynchronous collaboration, and that distinction is the key concept illustrated by an online class meeting. Students prepare for the online meeting by writing a short document on a given topic in small groups using a screen sharing program along with voice over IP (VoIP) and chat. This CIS 275 class used Yuuguu for screen sharing and Skype for VoIP and chat. These were selected somewhat arbitrarily because they met the criteria for free services that could support a session of 11 or more simultaneous users.

Table 3. Introducing the Web as a Platform for Communication.

Exercise	Concepts	Skills
Online Class Meeting	Latency	Screen sharing
	Synchronous vs. Asynchronous collaboration	Use Web tools for communication (IM, chat, video)
	Publish/subscribe model	Participate in a social network
	Custom client software versus AJAX applications	
	Desktop/Screen Sharing	
Tech Support	Desktop/Screen Sharing and Casting	Use Web tools for communication (IM, chat, video)
	Synchronous vs. Asynchronous collaboration	Remotely access and control someone else's computer over the Internet
	Custom client software versus AJAX applications	

The students ran preliminary tests to see whether the programs were fast enough to support effective collaboration. With two users, VoIP and chat latencies were not noticeable, but YuuGuu had to be run in limited-color mode to be used effectively.

For the online meeting, both the students and instructor remained at home, and the instructor conducted the class much as it would have taken place in the classroom, first giving a short lecture using a note from the class Web site, then demonstrating a social network created using Ning. The presentation and demonstration were identical to a classroom presentation and demonstra-

tion, and involved no extra preparation. Students were encouraged to make comments and ask questions as they would have in the classroom.

The instructor expected the students would find the low bandwidth channel less engaging than a classroom where everyone could see facial expressions and gestures; however, in a short survey after the exercise, the students reported that they were relaxed and less shy when online than in class. They also tended to focus more closely on the presentation, and were less likely to look at unrelated material on their computers than if in the classroom. The students ranged from neutral to preferring the online meeting.

Tech Support Exercise

In this exercise, students simulate an online help desk by connecting to and controlling another person's computer from a remote location.

Students learned a new feature of Windows or Office well enough to demonstrate it to their partners. Each student paired with another and remotely connected to a partner's computer with CrossLoop, a screen-sharing application (downloaded an installed from crossloop.com), to take control and demonstrate the feature they learned.

CrossLoop introduces another facet of social networking as it allows its users to charge for providing technical support. In such an integrated learning approach, traditional IT concepts (learning about an operating system or an office productivity tool) provide the content base for using Web 2.0 tools.

Students found this activity relevant. Many were surprised that they could remotely connect to another computer, which brought up issues related to computer security and privacy on the Internet. At the end of the exercise one student reported "My mom was having trouble with her computer, and I showed her how to install Crossloop so I could help her solve her problem."

7. STUDENTS DEFINE WEB 2.0 LITERACY

At the end of the semester, students generated lists of skills to master and concepts to understand that they felt were required to be Web 2.0 literate. After a small group brainstorming session, they shared their Web 2.0 Literacy Checklist with the rest of the class. Their notion of literacy revolved around soft skills, traditional computer literacy skills, basic Web skills, and Web 2.0 concepts and skills.

Soft Skills

- Effectively communicate with others
- Know how to keep personal information private and public information public
- Know how to decide whether information on the Web is real or accurate, and whether it is a scam

Traditional Computer Literacy Skills

- How to use database, spreadsheet, and productivity software
- How to navigate and maintain your computer

Basic Web Technology and Literacy Skills

- Synchronous Communication: AIM, Skype, Google Chat
- Asynchronous Communication: Email
- Create and edit audio, video, and images, and save in different formats
- Use FTP to upload files
- Create basic Web pages with HTML

Web 2.0 Concepts and Skills

- Understand how the Internet has evolved from one way to a participatory Web
- Find, subscribe to and read RSS feeds and podcasts using an aggregator
- Create and post to a blog, or comment on someone else's blog
- Contribute to a wiki
- Create, share, and post video to YouTube
- Use desktop sharing applications for collaboration
- Identify and interact with with Mashups, describe capabilities for new mashups
- Use online apps such as Google Docs and Spreadsheets for collaboration
- Create a presence on social networks: (Facebook, Twitter, LinkedIn, Flickr, Myspace)
- Use Creative Commons to share your work
- Use Delicious and Digg to categorize or rank information on the Web

8. STUDENT FEEDBACK

IT 101 Students reflected upon their learning and in a final blog post shared their take home message from the class.

Many identified the impact of the Internet in their own lives, and an understanding of the underlying technologies and applications that enable them to use the World Wide Web effectively:

> *Learning about Web 2.0 really made me see what the Internet is becoming. … So much of what happens in the real world is becoming virtual. This includes communication, jobs, socializing, shopping, and much more. This class showed me that the internet can be a platform for anything imaginable. We saw this with CrossLoop, to link computers, blogs to keep everyone up to date on [our ideas], Delicious for bookmarking information, RSS feeds to keep us up to date, and Twitter to tell us what our friends are doing.*

Some students were aware of Web 2.0 applications but took their features and capabilities for granted. They were empowered to become part of the Web 2.0 experience:

> *Before this class started, I had no idea that I was already part of a Web 2.0 world; I did not even realize that this was even a term. After finding out about this term, I began noticing things. I noticed how almost every website that I visited promoted user interaction. Everything on the web is contributed by the very people who use it.*

> *This is the take home message of [this class]: The Internet is always changing. … How are we going to immerse ourselves in this change and use it to enhance our lives? We learned … how Web 2.0 is connecting people around the globe and helping them keep in touch, reorganizing information to make it easier to find, helping people make and maintain business connections, and more. Now that we can see what Web 2.0 can do, it's our turn to see what we can make it do.*

Still others realized the impact of social networking in their own lives and the potential of the Internet in their own lives:

> *I wouldn't have expected a typical IT class to put so much emphasis on the so-cial aspect of the technology as well as how the actual technology works, but this is what really made the class interesting for me. The semester-long discussion we've had has changed the way I view the Internet as a social resource. [This class] emphasized that we are no longer in a world where we have an excuse not to be connected with the people around us because the web has become a platform that makes it incredibly easy to do.*

9. CONCLUSION

As the Web becomes a platform for developing and delivering applications, students need new skills which will serve them while in school, as citizens, and during their careers. These can and should be covered in an introductory technology course, so students will be able to make use of them in subsequent courses. The authors have developed and implemented several exercises that model real-world applications while illustrating traditional information technology skills and concepts as well as Web 2.0 skills and concepts.

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APPENDIX 1
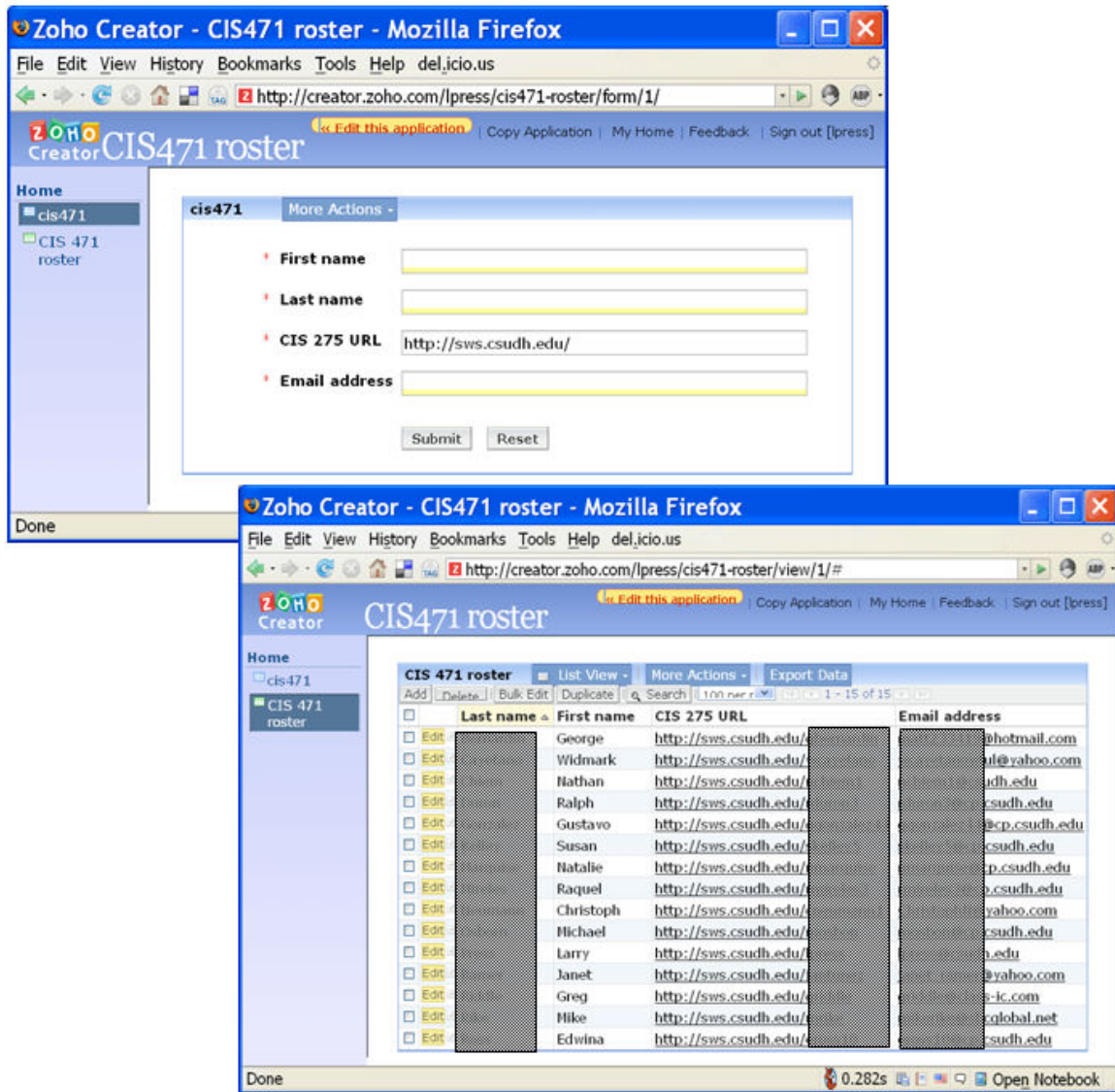
Figure 1. The ZohoWriter Version.
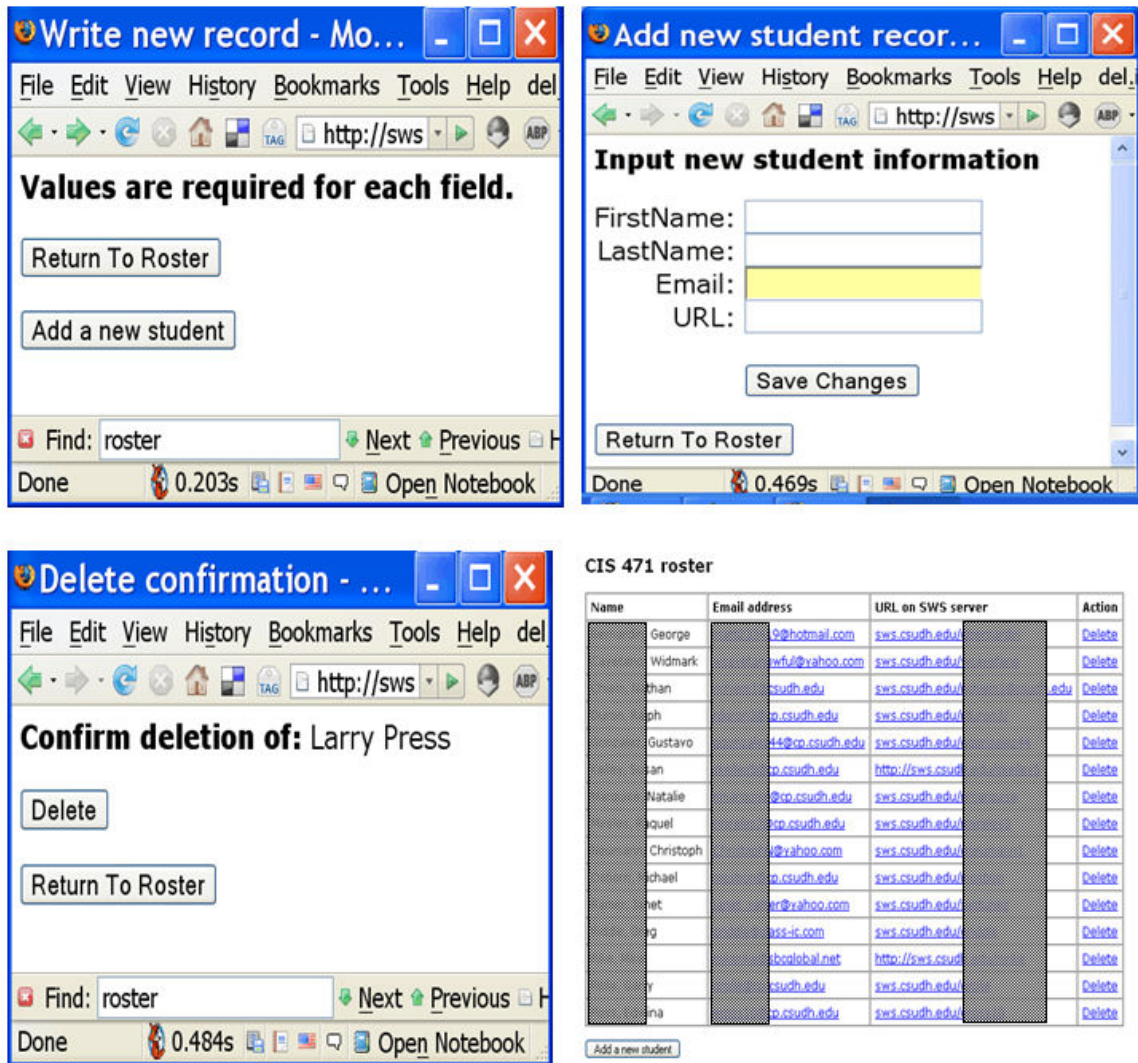
Figure 2. The Custom Web Application.
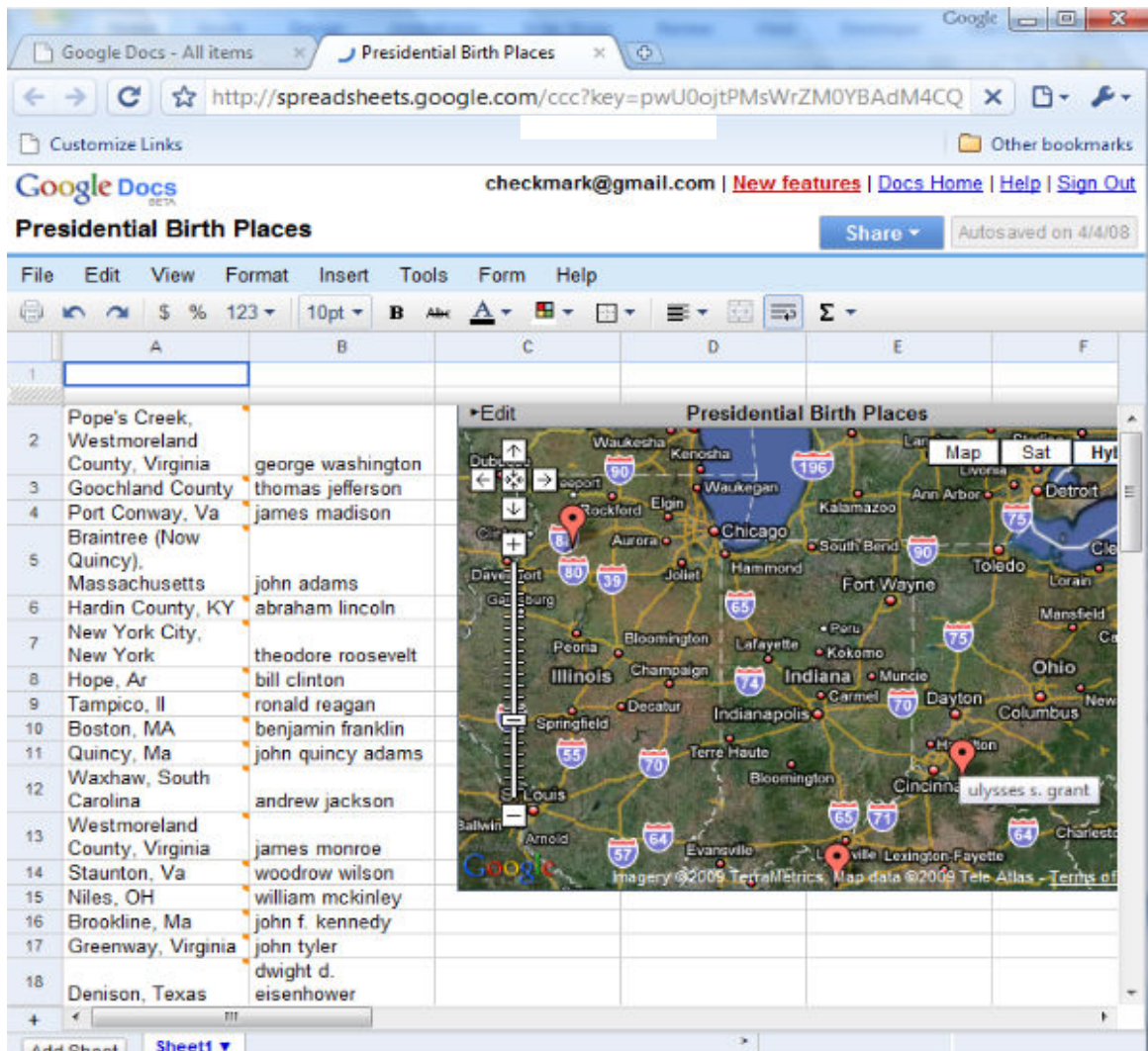
Figure 3. Google Spreadsheet Mashup

Application	Description
Blogger	Blogging Platform
AIM	Instant Messaging
Creative Commons	Rules for sharing and reusing intellectual property posted to the Web
Crossloop	Web-based desktop sharing
Delicious	Social Bookmarking
Digg	Social Ranking of News
Facebook	Personal social networking application
Flickr	Photo sharing
Gmail	Google's Web-based Email platform
Google	Search engine
Google Blog Search	Blog search engine
Google Docs and Spreadsheets	Web-based documents, spreadsheets, and presentations integrated with Google
Google Maps	Web-based mapping software
Google Reader	Web Feed (RSS/Atom) Reader
Google Sites	Wiki platform
iTunes	Podcast Aggregator
LinkedIn	Professional Social Networking Application
MySpace	Personal Social Networking Application
Ning	Social Network creation platform
PBworks	Wiki platform
Skype	VOIP Internet Telephony
Technorati	Blogging Index and Search
Twitter	Microblogging platform
YouTube	User-contributed videos
Yuuguu	Web-based desktop sharing
Zoho Creator	Web-based productivity and collaboration tools

Figure 4. Summary of Applications

APPENDIX 2

See the Google Spreadsheet online at http://tinyurl.com/yja8vut for a complete matrix of concepts and applications, along with a list of several applications used in the authors' classrooms.

Concept \ App	Browser/ srch eng	Soc bokmark	Image sharing	Video sharing	Blog	RSS	Thread Disc.	Productivity suites	Wiki	VoIP	List server	Class rosters	Maps	Desktop Sharing	Social network	Database	Project mgt.	Survey	Text editor	Image editor	Audio editor	Video editor	FTP client	Web client	Collab search	Micro blog	Strmg Audio	Strmg Video	Semantic DB
Cloud vs local storage	X		X	X	X		X	X	X				X		X	X													
Collaboration			X	X	X	X	X	X	X	X	X			X	X	X	X	X							X	X			
User content	X	X	X	X			X					X			X			X											
Text search	X							X	X																				
Tagging		X	X	X	X																								
Taxonomy	X																												
Relational model																X													
Semantic web										X																			X
One-one, one-many, many-many communication		X	X	X	X	X	X	X	X	X	X			X	X	X										X			
XML vs HTML					X	X			X						X	X			X										
Subscription to event streams						X	X																						
Publish-subscribe vs. polling						X		X																					
Software as a Service		X					X		X		X					X													
Internet writing style					X				X		X																		

Conversational writing	X		X				X	X	X		X								
Collaborative writing -- composite document						X	X	X				X							X	X
Collaborative writing -- common document						X	X													
Synchronous vs asynchronous collaboration						X		X	X	X										
Data types and encoding		X	X									X								
Image encoding													X							
Audio encoding														X						
Video encoding															X					
Data compression												X	X	X	X					
Analog vs digital data														X						
Mashup			X							X										