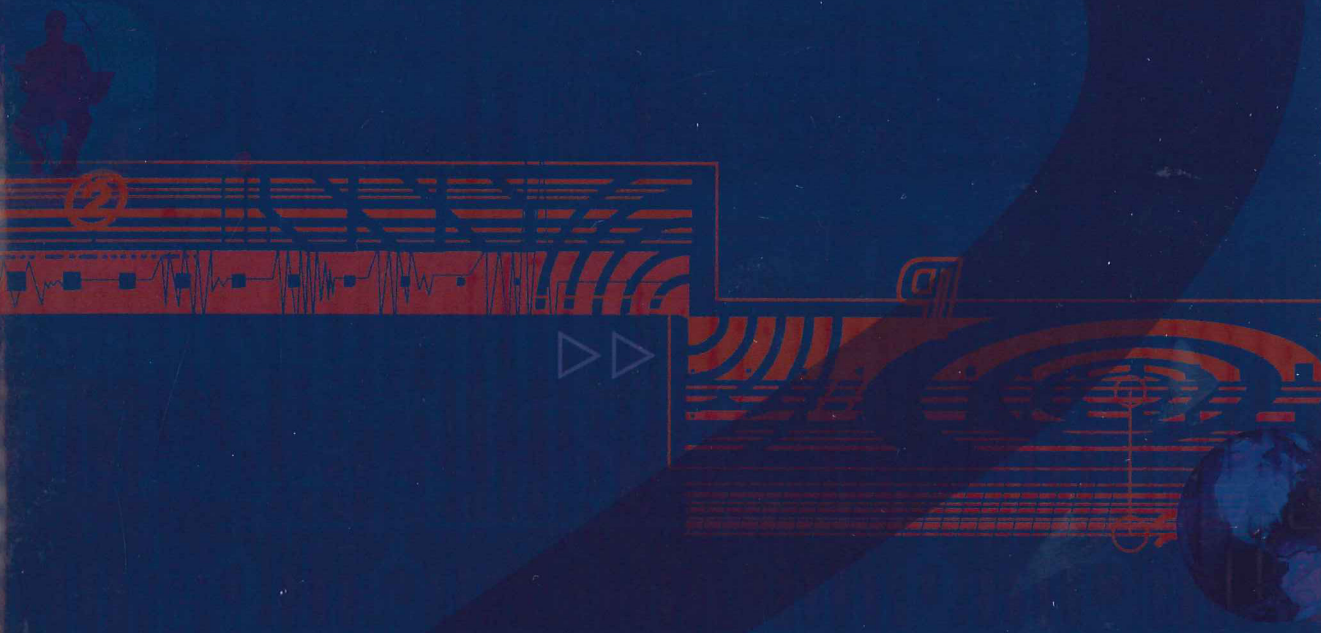
web 2.0
new tools, new schools



Gwen Solomon
Lynne Schrum

iste®

web 2.0
new tools, new schools

"A good read for those without any knowledge of Web 2.0 as well as experienced users." —*District Administration*

"The first full-length book to consider the impact of the second-generation Internet applications on pedagogy. … The book's style, helpful tips, and organizational structure will appeal across the education spectrum, from school to university teachers." —*International Journal of Emerging Technologies and Society*

What is Web 2.0? Once upon a time, Web sites were isolated information "silos"—all content and no functionality. Today, the next generation of Web sites gives power to the end-user, providing visitors with a new level of customization, interaction, and participation. What can Web 2.0 tools offer educators? *Web 2.0: New Tools, New Schools* provides a comprehensive overview of the emerging Web 2.0 technologies and their use in the classroom and in professional development. Topics include blogging, wikis, podcasting, and more. Also included are a discussion of Web 2.0 safety and security issues and a look toward the future of the Web 2.0 movement. *Web 2.0: New Tools, New Schools* is essential reading for teachers, administrators, technology coordinators, and teacher educators.

Gwen Solomon is director of techLEARNING.com, the award-winning Web site of *Technology & Learning* magazine. Past positions include senior analyst in the U.S. Department of Education's Office of Educational Technology and coordinator of instructional technology planning for New York City Public Schools.

Lynne Schrum is professor and coordinator of elementary and secondary education in the College of Education at George Mason University. She is a past president of the International Society for Technology in Education and a past editor of the *Journal of Research on Technology in Education*.

AUDIENCE

Grade K–12 teachers, technology coordinators, school and district administrators, teacher educators, library media specialists

FEATURES

A complete explanation of Web 2.0 tools, including blogs, wikis, folksonomies, RSS feeds, and podcasts

Web 2.0 tools and their use in the classroom

Web 2.0's role in professional development

What administrators should know about Web 2.0

KEYWORDS

Web 2.0, technology literacy, technology integration, teacher training, curriculum design

Education/Technology

ISBN 978-1-56484-234-3

iste International Society for Technology in Education

www.iste.org

Contents

introduction 1

1 **new world, new web, new skills** 7

New World 8
Economics 102 9
New Web 12
New Corporations 16
21st-Century Skills 17
Schools and Change 21
The Tipping Point 21
New Tools and Learning 23
Taking Advantage of New Tools 24

2 **students and learning** 25

21st-Century Students 26
How Children Get Information 30
What Students Want from Their Schools 31
The Customization Generation 33
Access to Online Tools and Services 34
Understanding Learning 35
Constructivism 38
Project-based Learning 39
Connectivism 40
The Challenge 41
Harnessing New Technologies 42

3 **new tools** 45

Concepts 46
The Web as Platform 46
Behind the Web Tools 48
Open Source 50

Tagging and Syndication 52
From the Web to Web 2.0 54
Using the Tools 55
Basic Web 2.0 Tools: Blogs, Podcasts, and Wikis 55
Other Popular Web 2.0 Tools 58
Web 2.0 Versions of Desktop Tools 62
Web 2.0 Management Tools 65
Other Web 2.0 Tools for Education 66
More New Tools 69
Educational Software 71
Immersive Environments 75
Data and Design 76

4 **new tools in schools** **77**
Cool Schools 78
Classroom Applications: Using the Tools for Learning 80
Classroom Applications: Teaching Content 84
Other Tools and Models 97

5 **professional development** **99**
Creating Effective Programs 102
Preservice Learning 102
Communities of Practice 103
Technology Literacy Training 111
Professional Development and Web 2.0 Tools 112

6 **leadership and new tools** **117**
Leading in the 21st Century 118
Using New Tools 120
Supporting New Tools 128
Financial Issues 129
Infrastructure: Running on Open Source 134

7 **online safety and security** 137

Legal Requirements 138
Copyright and Intellectual Property 139
Security Solutions 140
Knotty Problems 152
Other Alternatives 156

8 **systemic issues** 159

English Language Learners and English as a Second Language 160
Students with Special Needs 163
Equity and the Digital Divide 165
Assessment 168

9 **new schools** 177

Harnessing the Collective Intelligence of Education Data 178
The Long Tail of Educational Materials 179
The Vision and the Reality 180
Polls and Surveys 181
Software 181
Textbooks 182
Moving Applications and Data Online 183
Open-Source Educational Applications 183
Professional Development 186
Toward a Smart Future 186
Brainstorming about Schools and Web 2.0 188
Your Turn 189

10 **tutorials** 191

Web-based Word Processor: Zoho Writer 192
Web-based Spreadsheet: Num Sum 194
Open-Source Painting Tool: Tux Paint 195
Editing Sound: Do You Have Audacity? 196
Syndication in Firefox: RSS Feeds 197

introduction

let's start with a pop quiz

YES OR NO:
Have you ever blogged, podcasted, wikied, showed photos, or commented online?

If you said *yes* and reside in the United States, you're among 48 million people who have tried these new tools (Horrigan, 2006). If you said *no* but are still reading this, you obviously are curious about these latest technological innovations.

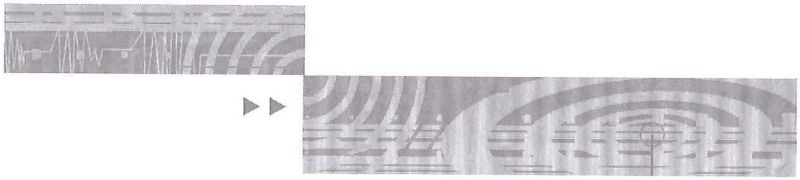
Welcome to the New Web, most often called Web 2.0. It is all about the free new tools such as blogs, wikis, photo and video sharing, and social networking that people are talking about and that many are using already.

What do they mean for education? These tools are changing how people, including our students, interact with the world. The changing nature of information and the new ways our students understand and make sense of the world signal that we need new strategies and new tools for teaching and learning. The challenges of the new millennium require that students be adaptable and analytical, and that they have the skills to identify and use the best tools in a rapidly changing environment.

Why should you care about these new tools and methods? After all, in spite of all the hype, technology has not yet changed schools very much. So why now—in an era of No Child Left Behind and high-stakes testing—should we care?

As you will see, the world has changed; our students have changed, and traditional schools are no longer up to the task of educating young people for the future.

You may say that the Web as we have known it is good enough, that these new tools are uncontrollable and students are venturing into uncharted territory. What was so bad about last year's tools?



1

new world, new web, new skills

Think back to when you were in school; consider how different everything was then. There was a simpler, clearly defined path to the future, or so it seems in retrospect. While that may or may not have been true for all of us back then, no one today would view the world or the path to the future as being simple.

new world

We live in a wired, globalized world in which communication and collaboration are possible 24/7. Corporations have become multinational and their workers can be anyplace and work at any time. Fast connections and standardized software link these corporations with workers wherever they are, and some members of this workforce live in parts of the world where salaries are low and benefits are unheard of. Technology is the driving force that created this environment. Technology makes people in remote locations viable employees who are eager to have the jobs.

Companies use technology to become lean and efficient. They can track their goods and services from point of origin to delivery and at every step along the way. They know what they need at any moment and can make adjustments to the supply flow in real time using technology from a distance. They trim expenses, including worker costs. When workers in Asia are as well educated as Western graduates, are just as well versed in using new tools, and require significantly smaller salaries, it is clear where the jobs will go.

By the early 2000s, the notion of interactivity went from linking and clicking to creating and sharing. Now individuals not only find and read information but also create and share their own in real time. It is a new Web, known as Web 2.0.

The Web is changing too. It has morphed from static HTML pages where readers could find and copy information to interactive services, where visitors can create and post information. The transition from using desktop-based applications to new online tools means that we can work differently. We no longer just find and use information; the Web is now a participatory, interactive place where we create information collaboratively and share the results. Everyone can participate thanks to social networking and collaborative tools and the abundance of Web sites that allow us to post journals, photos, movies, and more. The Web is no longer a one-way street where someone controls the content. Anyone can control content in a Web 2.0 world.

So what does this mean for teaching and learning? As educational leaders, we should understand changes in the Web and how they reflect changes in the world

3. The innovation must clearly address an instructional need, with benefits for both teacher and student.
4. The innovation must add value to an instructional process.
5. There must be visible and tangible results indicating that the innovation improves student learning.
6. The technology has been taken out of the technology or innovation.
7. The teacher has become a confident, active, and visible user; use becomes seamless and transparent. (n.p.)

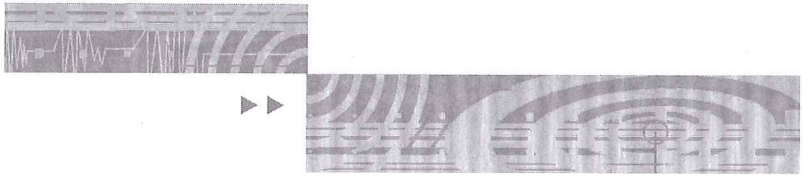
new tools and learning

One exciting aspect of Web 2.0 tools is that they are free programs that could replace the traditional application suites for which schools ordinarily must pay. Some perform the familiar functions, such as word processors, spreadsheets, and presentation tools. While they may not have every single feature of Microsoft Word, Excel, or PowerPoint, there is an advantage to having software that is Web-based: people at different computers can use the software to collaborate on a single document or on sets of documents at the same time.

Web 2.0 is an ever-growing array of tools that people use to aggregate and interact with information in ways that are useful to them. Figure 1.1 shows several distinctions between the old and new ways of doing things, dubbed as Web 1.0 and Web 2.0.

Figure 1.1 | Comparison of old and new ways of working

Web 1.0		Web 2.0
Application based	▶	Web based
Isolated	▶	Collaborative
Offline	▶	Online
Licensed or purchased	▶	Free
Single creator	▶	Multiple collaborators
Proprietary code	▶	Open source
Copyrighted content	▶	Shared content



2

students and learning

While using the Web has changed the world and the workplace of the 21st century, nowhere has it had a greater effect than on the lives of young people. They play video games, communicate using text messaging and instant messaging, conduct Internet searches, download music and share files (legally, we hope), and use the Web for homework. These technologies have always been available to them. Their parents and teachers and the rest of us who weren't born into a technologically interactive world have to struggle to keep up.

Marc Prensky is a speaker, writer, consultant, and educational software game designer whose theory about the differences between today's teens and the adults in their lives defines the generation gap. He calls students digital natives, people who live in a world where technology is omnipresent. He calls their parents and teachers (and us) digital immigrants, well-meaning adults who have to work at being comfortable with technology.

According to Prensky (2001), today's students:

- Are no longer the people our educational system was designed to teach
- Have not just changed incrementally from those of the past ... our students have changed radically
- Represent the first generations to grow up with this new technology
- Think and process information fundamentally differently from their predecessors
- Are all "native speakers" of the digital language of computers, video games, and the Internet (p. 1)

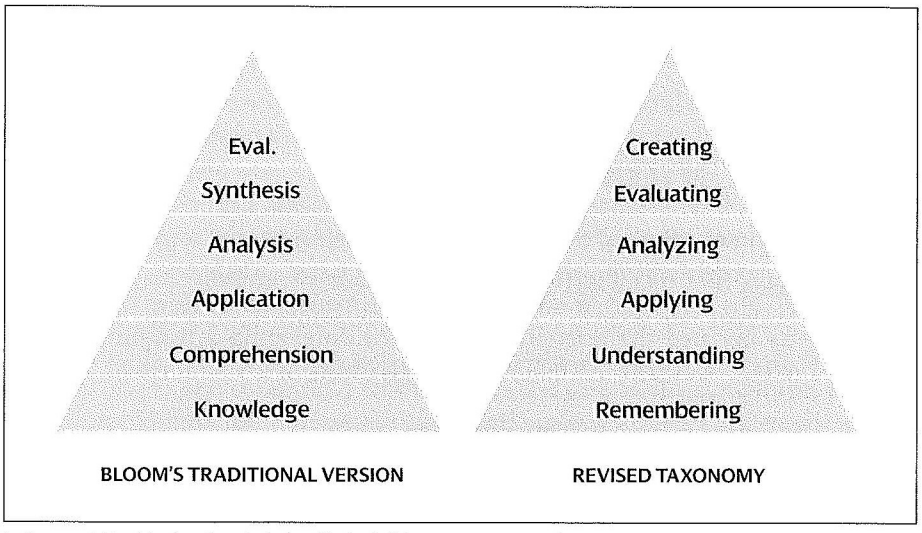
Of course, many adults (including tech coordinators and many teachers) are just as comfortable with technology as the most advanced teen. And, unfortunately, many students cannot afford 24/7 access to technology and thus cannot be facile. However, the definitions are useful for understanding that today's students are likely to be a wired generation and that today's teachers and parents are likely to need a little help from their young friends.

21st-century students

How wired are students? Of American households, 71% have Web access, and Americans age 13–24 now spend more time online than they do in front of the TV (Sloan & Kaihla, 2006). Seventy percent of YouTube's registered users are American; roughly 50% are under 20 (Gomes, 2006). They communicate with friends through instant messaging, download music to their iPods and MP3 players, hang out on MySpace, surf the Web, and meet friends online.

have the capacity to support higher order thinking and more engaged learning. The revised taxonomy addresses the needs of today's students (Krathwohl, 2002).

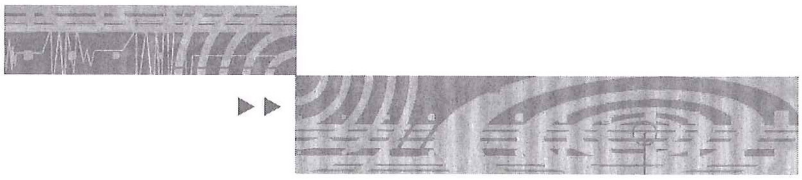
Figure 2.1 | Comparison of the revised taxonomy with Bloom's traditional version



▶ Source: http://web.odu.edu/educ/llschult/blooms_taxonomy.htm

In Figure 2.1, note the change from nouns to verbs (e.g., Application to Applying) to describe the different levels of the taxonomy (Schultz, 2005). Anderson and Krathwohl (2001) explain these terms as follows:

> **Remembering.** Retrieving, recognizing, and recalling relevant knowledge from long-term memory.
>
> **Understanding.** Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.
>
> **Applying.** Carrying out or using a procedure through executing, or implementing.
>
> **Analyzing.** Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through differentiating, organizing, and attributing.

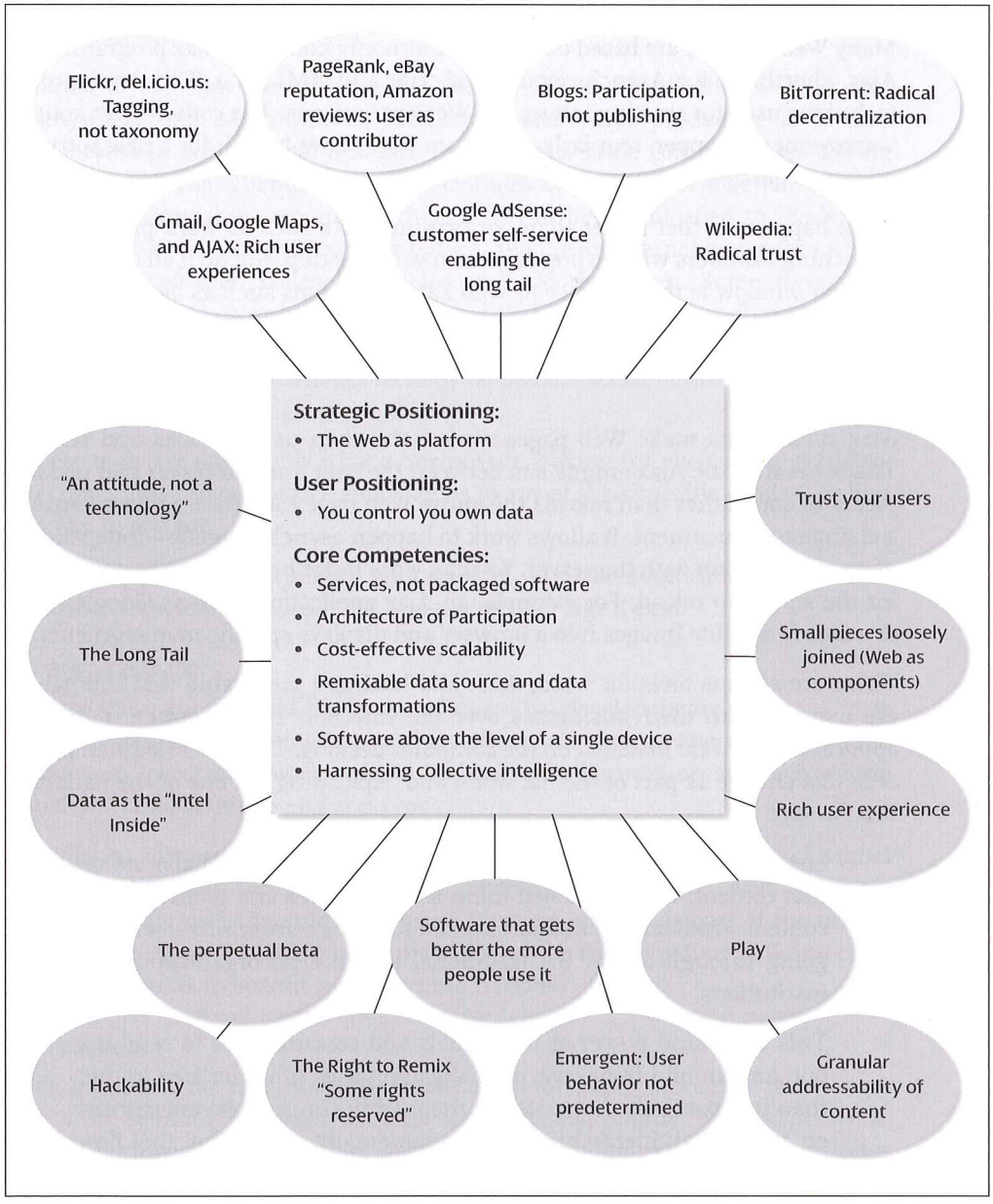


3

new tools

On October 18, 2006, YouTube featured a music video by ClipBandits, a band with three young men that called itself "The World's First Web Band" because they formed the group, developed the music, and created the video all online. In fact, they had never met, didn't know one another's real names, and lived in New York, Los Angeles, and Austin. They were searching for a drummer by soliciting audition videos. In three days, nearly 500,000 people watched the video and almost 1,700 people posted ratings (it got four out of five stars). This is the world our students live in. How did we get here? And just what does this mean for education?

Figure 3.1 | Web 2.0 meme map

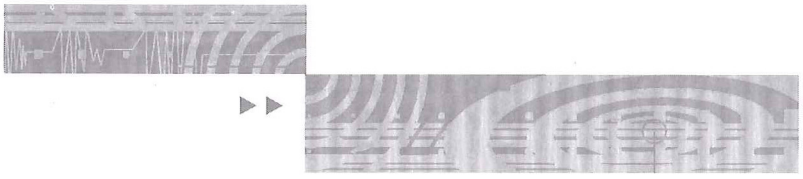


▶ © 2005 O'Reilly Media, Inc. Reprinted with permission from "What is Web 2.0."

4

new tools in schools

Thus far, this book has presented information on the changing nature of information, new ways our students understand and make sense of the world, and strategies for rethinking the ways teachers can take advantage of new methods for teaching and learning. The book also described these new tools that offer new opportunities for students to learn, explore, and present their knowledge; these models are often termed "social software," a phrase attributed to Clay Shirky (2003) to describe technologies that facilitate group communication.



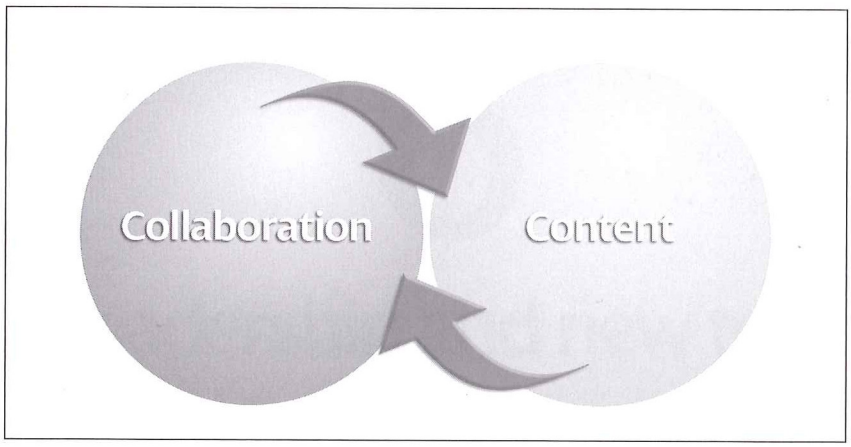
5

professional development

In the past few decades, a transformation has occurred in American public education; now, teachers are expected and required to use educational technology in one form or another in their classrooms (Collier, Weinburgh, & Rivera, 2004). As technology improves, many school districts adopt new methods to enhance communication, teaching, and learning.

Wikispaces (http://teacherconnect.wikispaces.com) is a teacher-to-teacher global network with a stated goal to "Link a profile to a network to a network" and to encourage teachers and students to provide information about the very best places to interact with others interested in education. Teachers can find information on many topics (self-directed professional development), create links to student projects throughout the world, and access links to other wikis and blogs.

Figure 5.1 | Relationship and interaction between content and collaboration



▶ Source: http://writingwiki.org/default.aspx/WritingWiki/ForTeachersNewtoWikis.html

Additionally, some organizations are working to promote the growth of interaction about particular topics for their members. One is a wiki called Library Success (www.libsuccess.org), which offers information for all types of librarians to share their successful programs and innovative projects using technology. This wiki serves as a collaborative site with information on best practices, training, and other professional topics.

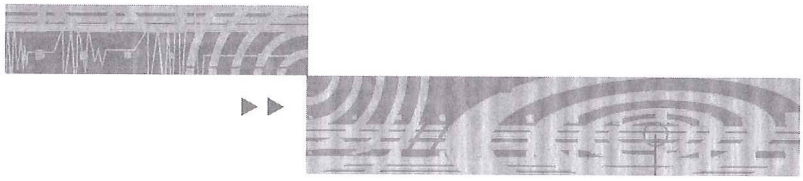
Finally, even preservice educators are invited to participate in wikis to learn about their future profession and activities. Future Teachers Meet Wiki (http://en.wikibooks.org/wiki/Future_Teachers_Meet_Wiki/) is one site that encourages teacher candidates to explore new ways of teaching and learning and to promote interaction among the next generation of teachers.

Encouraging our educators and schools to use technology effectively is a complicated and challenging task. Using these new tools as models and methods to teach about them accomplishes two goals. It first provides practice and comfort with the tools,

6

leadership and new tools

Being a school or district administrator has never been an easy occupation, but today they have more issues to deal with than ever before. Technology makes many tasks easier but it also adds complexities peculiar to this digital age. While much time is spent in dealing with administrative issues, a principal or district administrator is more than ever an educational leader with responsibilities for guiding classroom activities and focusing thoughtful attention on the intellectual growth of students and teachers.



7

online safety and security

No conversation about students and Web-based activities would be complete without remarking on the threats that lurk online. Keeping students and data safe and secure are important—ethically and legally. School districts have to do everything in their power to prevent problems before they start.

Table 7.1 | IS IT STEALING?

Proportion of young people who thought the following would be committing a crime	Ages 12–14	Ages 15–17	Ages 18–20	Ages 21–24
Copying a CD from a friend who paid for it	27%	35%	33%	38%
Copying a DVD/videotape from a friend who paid for it	39%	44%	40%	41%
Downloading free music from an unauthorized file-sharing server	79%	81%	70%	79%
Downloading free movies from an unauthorized file-sharing server	83%	83%	74%	79%
Buying a bootlegged CD	84%	84%	76%	76%
Buying a bootlegged DVD/videotape	84%	84%	80%	77%
Shoplifting an item worth less than $20	97%	97%	98%	96%
Shoplifting an item worth more than $20	99%	99%	99%	97%

© Los Angeles Times. Reprinted with permission.

Because there are so many new issues that confront students on the Web and new concerns for educators, adopting a code of ethics to supplement acceptable use policies may make sense. The Student and Teacher Information Code of Ethics sidebar by David Warlick (2006d) offers suggestions on creating such a document.

A Student and Teacher Information Code of Ethics

Seek Truth and Express It

Teachers and students should be honest, fair, and courageous in gathering, interpreting, and expressing information for the benefit of others. They should:

- Test the accuracy of information from all sources and exercise care to avoid inadvertent error.
- Always identify sources. The consumers of your information product must be able to make their own judgment of its value.
- Always question the sources' motives.
- Never distort or misrepresent the content of photos, videos, or other media without explanation of intent and permission from the information's owner. Image enhancement for technical clarity is permissible.
- Tell the story of the human experience boldly, even when it is unpopular to do so.
- Examine your own cultural values and avoid imposing those values on others.
- Avoid stereotyping by race, gender, age, religion, ethnicity, geography, sexual orientation, disability, physical appearance, or social status.
- Give voice to the voiceless; official and unofficial sources of information can be equally valid.
- Distinguish between opinion and fact when expressing ideas. Analysis and commentary should be labeled and not misrepresent fact or context.

Minimize Harm

Ethical teachers and students treat information sources, subjects, colleagues, and information consumers as human beings deserving of respect.

- Gathering and expressing information should never cause harm or threaten to be harmful to any one person or group of people.
- Recognize that private people in their private pursuits have a greater right to control information about themselves than do others.

8

systemic issues

Schools face challenges that are unique to their district, city, and region and must address their local constituency's concerns all the time. In addition, there are some universal or systemic issues that all schools must consider and respond to through their programs, activities, and professional development. These issues may come sharply into focus when considering technology, and in particular, the use of Web 2.0 tools. This chapter examines the implementation and possibilities for not only using these tools in the curriculum, but also using the tools in ways to create opportunities for all learners in a community.

assessment, and thus to portfolios. Table 8.1 presents my comparison of electronic portfolios used as assessment *of* learning with those that support assessment *for* learning, based on work done in Britain by the Assessment Reform Group (see www.arg.educ.cam.ac.uk). This table has been published in previous work.

Table 8.1 Comparison of Electronic Portfolios by Type of Assessment

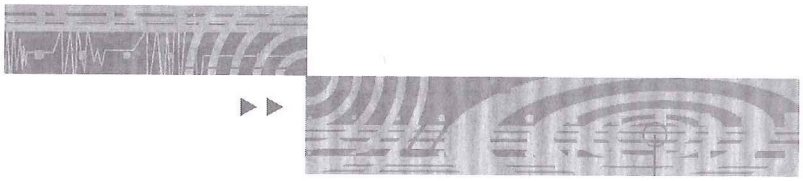
Portfolios used for Assessment *of* Learning	Portfolios used for Assessment *for* Learning
The purpose of the portfolio is prescribed by the institution.	The purpose of the portfolio is agreed upon with the learner.
Artifacts are mandated by the institution to determine the outcomes of instruction.	Artifacts are selected by the learner to tell the story of their learning.
The portfolio is usually developed at the end of a class, term, or program (time limited).	The portfolio is maintained on an ongoing basis—throughout the class, term, or program (time flexible).
The portfolio and/or artifacts are usually "scored" based on a rubric, and quantitative data are collected for external audiences.	The portfolio and artifacts are reviewed with learner and used to provide feedback to improve learning.
The portfolio is usually structured around a set of outcomes, goals, or standards.	The organization of the portfolio is determined by the learner or negotiated with a mentor/advisor/teacher.
Portfolios are sometimes used to make high-stakes decisions	Portfolios are rarely used for high-stakes decisions.
Portfolios are summative—what has been learned to date (past to present)?	Portfolios are formative—what are the learning needs in the future (present to future)?
The process requires extrinsic motivation.	The process fosters intrinsic motivation and engages the learner.
The audience is external; there is little choice.	The audience can be the learner, family, or friends; the learner can choose.

In summary, as I review all of these comparisons, I have come up with a new look at e-portfolios from the framework of Web 2.0, which I will call ePortfolio 2.0. Other terms might be "blog-folios" or "wiki-folios" or perhaps "iPortfolios" (i=interactive). Table 8.2 offers a comparison of early electronic portfolios and Web 2.0 portfolios.

Table 8.2 Comparison of Electronic Portfolios by Type of Technology

ePortfolios 1.0		ePortfolios 2.0
Hierarchical, designed	▶	Networked, emergent
Metaphor: portfolio as checklist	▶	Metaphor: portfolio as story
Data-driven	▶	Learner-driven
Focus on standardization	▶	Focus on individuality, creativity
Feedback from authority figures	▶	Feedback from community of learners
Large, complex systems	▶	Small pieces, loosely joined—"mash-ups"
Web-based form	▶	Blog and wiki
Positivist	▶	Constructivist, connectivist
Accountability-driven	▶	Learning-focused
Proprietary	▶	Open standards
Digital paper (text and images)	▶	Digital story (multimedia)
Local storage (hard drives, CD)	▶	Network storage (lifetime personal Web space)

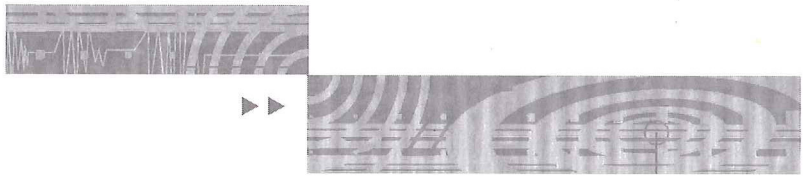
What are some of the advantages of an interactive portfolio? Just as the Web changed with the implementation of the architecture of interaction, we could say that portfolios have the potential to change with the pedagogy of interaction, especially as used within a paradigm of assessment for learning. With these new tools, we can post work and invite feedback, as in a blog; we can post work and invite co-authors, as in a wiki. Fortunately, wiki tools keep track of the changes, so that authorship can be tracked, if that is important for accountability. As I wrote for an article submitted to the Connected Newsletter (2006):



9

new schools

Everything changes fast in this Web 2.0 world. Some of the applications and Web sites described in this book may already be out of fashion and new ones may have emerged as the new "new thing." However, it is certain that digital technologies and new Web applications have made a huge difference and are here to stay. The real issue is what we should do with these technologies for the future of teaching and learning. What should we expect from new schools?



10

tutorials

In chapter 3, we discussed Web 2.0 tools such as basic applications for word processing, spreadsheets, and presentations; new communication tools including blogs and wikis; and creative tools such as those used for photo editing, audio editing, and drawing. A more extensive compendium of tools is listed in appendix B. This chapter introduces tutorials for just a few representative tools that you can use when you're ready to get started.

A

web timeline

Adapted from Fifteen Years of the Web, by BBC News
http://news.bbc.co.uk/1/hi/technology/5243862.stm

AUGUST 6, 1991

Tim Berners Lee, a scientist at the world's largest particle physics laboratory, the European Organization for Nuclear Research (known as CERN), formally introduced his World Wide Web project to the world on the alt.hypertext newsgroup.

DECEMBER 12, 1991

Following a trip to CERN, where he met Tim Berners Lee, scientist Paul Kunz of the Stanford Linear Accelerator Center in the U.S. was inspired to set up North America's first Web server.

NOVEMBER 1992

26 Web servers were online.

APRIL 22, 1993

Mosaic, the first Web browser to run on the Windows operating system, was released. Developed at the National Center for Supercomputing Applications in Illinois, it provided a user-friendly way to navigate Internet information.

B

web 2.0 tools

Blogging

Blogger (www.blogger.com). A really easy-to-use site that allows even non-technical types to start a blog in just three basic steps using a range of templates. The site was started in the dotcom boom of 1999 and is now part of Google.

Class Blogmeister (http://classblogmeister.com). David Warlick created this site specifically for classroom educators who want full control over the blogs created by, read by, and used by students. Teachers can evaluate, comment on, and publish students' blogs entries in a controlled environment.

Drupal (http://drupal.org). Drupal is software that allows an individual or a community of users to publish, manage, and organize content on a Web site. It can enable blogs, collaborative authoring environments, content management systems, forums, newsletters, and picture galleries.

Edublogs (http://edublogs.org). An easy-to-use blog-creation site with customizable templates (themes) for educators, K–12 and college students. Blogs created with it will include links to Chalkface, an assessment tool; to IncSub, dedicated to online projects; and to BlogSavvy, which helps bloggers become better bloggers.

a day in the life of web 2.0

David Warlick

The latest powerful online tools can be harnessed to transform and expand the learning experience.

An eighth-grade science teacher, Ms. S, retrieves her MP3 player from the computer-connected cradle where it's spent the night scanning the 17 podcasts she subscribes to. Having detected three new programs, the computer downloaded the files and copied them to the handheld. En route to work, Ms. S inserts the device into her dash-mounted cradle and reviews the podcasts. She selects a colleague's classroom presentation on global warming and a NASA conference lecture about interstellar space travel.

As with all the teachers at her middle school, Ms. S keeps a regular blog, where she writes about everything from homework assignments to reflections on course topics, with a full description posted each Monday morning on the how, what, and why of course material to be taught in the upcoming week.

The teachers' blogs are all syndicated using RSS—Rich Site Summary, or the more informal and descriptive Really Simple Syndication. With aggregation software, students, parents, administrators, and other teachers can subscribe and have the freshly written blog entries immediately and automatically delivered to their desktops. Professional development, communication, cross-curricular lesson planning, and articulation among grade levels are all served as educators

D

references

A

ALA TechSource. (2007). *A "new media" information-literacy tool.* Available: www.techsource.ala.org/blog/2006/04/a-new-media-information-literacy-tool.html

Alexander, B. (2006). Web 2.0: A new wave of innovation for teaching and learning? [Electronic version]. *EDUCAUSE Review, 41*(2), 32–44. Retrieved December 8, 2006, from www.educause.edu/apps/er/erm06/erm0621.asp

Allen, L. Q. (2006). Investigating culture through cooperative learning. *Foreign Language Annals, 39*(1), 11–21.

American Digital Schools. (2006). *The America's Digital Schools 2006 national survey.* Retrieved November 3, 2006, from www.ADS2006.org

Amrein, A. L., & Berliner, D. C. (2003). The effects of high-stakes testing on student motivation and learning. *Educational Leadership, 60*(5), 32–38.

Anderson, C. (2006). *The long tail: Why the future of business is selling less of more.* New York: Hyperion.

Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). *A taxonomy for learning, teaching and assessing: A revision of Bloom's Taxonomy of educational objectives: Complete edition.* New York: Longman.

Armstrong, E. (2006). *Gummy Bears: A graduated jellybean.* Available: http://gr10pc-gb.blogspot.com/2006/09/multiplying-and-dividing-polynomials.html