

Educational Researcher

<http://er.aera.net>

Learning, Teaching, and Scholarship in a Digital Age :

Christine Greenhow, Beth Robelia and Joan E. Hughes

EDUCATIONAL RESEARCHER 2009 38: 246

DOI: 10.3102/0013189X09336671

The online version of this article can be found at:

<http://edr.sagepub.com/content/38/4/246>

Published on behalf of



American Educational Research Association

and



<http://www.sagepublications.com>

Additional services and information for *Educational Researcher* can be found at:

Email Alerts: <http://er.aera.net/alerts>

Subscriptions: <http://er.aera.net/subscriptions>

Reprints: <http://www.aera.net/reprints>

Permissions: <http://www.aera.net/permissions>

>> [Version of Record](#) - Jun 9, 2009

[What is This?](#)



Learning, Teaching, and Scholarship in a Digital Age

Web 2.0 and Classroom Research: What Path Should We Take Now?

Christine Greenhow, Beth Robelia, and Joan E. Hughes

Since Windschitl first outlined a research agenda for the World Wide Web and classroom research, significant shifts have occurred in the nature of the Web and the conceptualization of classrooms. Such shifts have affected constructs of learning and instruction, and paths for future research. This article discusses the characteristics of Web 2.0 that differentiate it from the Web of the 1990s, describes the contextual conditions in which students use the Web today, and examines how Web 2.0's unique capabilities and youth's proclivities in using it influence learning and teaching. Two important themes, *learner participation and creativity* and *online identity formation*, emerged from this analysis and support a new wave of research questions. A stronger research focus on students' everyday use of Web 2.0 technologies and their learning with Web 2.0 both in and outside of classrooms is needed. Finally, insights on how educational scholarship might be transformed with Web 2.0 in light of these themes are discussed.

Keywords: classroom research; computers and learning; educational reform; instructional technologies; research methodology; technology

More than a decade ago, Windschitl (1998) and others (Hartley & Bendixen, 2001; Owston, 1997; Roschelle & Pea, 1999), writing in *Educational Researcher*, outlined opportunities and contemporary practices in the use of the Web as an educational tool in classrooms. For example, in regard to the Web's role in classrooms, Windschitl advocated for a stronger research focus on three topics: using the Web for student inquiry, studying student communication via the Web, and invoking qualitative research methods to illuminate Web-based learning. Windschitl described the Web's potential to function as an information repository that could promote richer inquiry

experiences for learners, and he argued for more research that examined students' inquiry processes with the Web and the teacher's role in guiding and evaluating such processes. Emphasizing learners' abilities to communicate with an international audience through the Web, Windschitl also argued for deeper investigations of how virtual global communication experiences, such as e-pen-pal programs, shape participants' values, attitudes, and beliefs about other cultures. Windschitl suggested that researchers need to invoke qualitative research methods in order to discover, document, and describe complex changes occurring in the context of Web-based teaching and learning. These changes could include revised roles for teachers and students and new ways of interacting. Indeed, in the past 10 years, researchers have used a variety of methods to understand how the Web functions as an information repository and communication tool for learning; yet 10 years later, the Web has been transformed in terms of its penetration of use and its very essence—significant transformations that we felt necessitated another examination of the Web's role in teaching and learning.

Transformations of Web Access, the Web, and the “Classroom”

Web Access

In the past 10 years, Web access, the nature of the Web, and contexts for learning have been transformed, along with the emergence of desired technological competencies for learners, teachers, and administrators. Internet connectivity in schools, homes, neighborhoods, and communities has become increasingly pervasive. Since the mid-1990s, the percentage of public schools connected to the Internet exploded from 35% to 100%. Public instructional classrooms with Internet access grew to 94%, up from 14% a decade earlier, and the ratio of students per Internet-connected instructional computer decreased from 12:1 to 3.8:1 (Wells & Lewis, 2006). Outside of schools, more than two thirds of people in the United States have Internet connections at home, more than half of which are broadband (Horri-

Educational Researcher, Vol. 38, No. 4, pp. 246–259
DOI: 10.3102/0013189X09336671
© 2009 AERA. <http://er.aera.net>

2008), and by 2014, it is estimated that 90% of all people in the United States will be online with dramatically faster, high-speed networks (Fox, Anderson, & Rainie, 2005). Ninety percent of school-age youth use the Internet, with adolescents ages 12 to 17 representing the largest and fastest-growing group of users (DeBell & Chapman, 2006; Lenhart, Arafeh, Smith, & Macgill, 2008; Lenhart, Madden, & Hitlin, 2005). Recent national surveys report that the majority of teenagers go online daily or several times a day, mostly from home (Lenhart et al., 2008; Macgill, 2007).

The Web Then and Now

As Web access expanded, the nature of the Web also changed dramatically. Ten years ago, the “first-generation web” or “Web 1.0” (Cormode & Krishnamurthy, 2008, p. 1) was viewed as an educational and communication resource akin to conventional or “familiar” classroom resources, for example, a source of information, such as a book; a means of representing content, such as an overhead transparency; or a means of communicating information, such as a visiting speaker (Wallace, 2004, p. 449). Web 1.0 predominantly, although not exclusively, involved hierarchically arranged websites with information largely controlled by a small group of content providers (Cormode & Krishnamurthy, 2008). Most users browsed, read, and obtained information and were directed through a site from a common entry point or “front page” (Cormode & Krishnamurthy, 2008, p. 5). Individuals with programming expertise in hypertext markup language (HTML) could post content, but Web 1.0 accommodated only modest individual knowledge creation and sharing, mostly through primarily text-based online forums and archived listservs. Conceptually, Web 1.0’s design, processes, and outcomes embodied a “classical” perspective of “authenticated” knowledge compiled by “experts with substantial credentials in academic fields and disciplines,” who through formal, evidence-based argumentation generated and presented findings and conclusions (Dede, 2008, p. 80).

“Web 2.0,” a term coined in 2004, characterizes a transition from the predominantly read-only Web 1.0 into a “read-and-write” Web 2.0 (McManus, 2005, para. 1). Web 2.0 facilitates “participatory,” “collaborative,” and “distributed” practices within Web 2.0-enabled formal and nonformal spheres of everyday activities (Lankshear & Knobel, 2006, p. 38). Other terms used to characterize Web 2.0 include “relationship” technologies (Schrage, 2001, para. 6), “participatory media” (Bull et al., 2008, p. 106), and “social digital technologies” (Palfrey & Gasser, 2008, p. 1).

Web 2.0 is both a platform on which innovative technologies have been built and a space where users are as important as the content they upload and share with others (Cormode & Krishnamurthy, 2008). Web 2.0 includes social networks, such as MySpace, Facebook, and Ning; media sharing, such as YouTube and Flickr; social bookmarking, such as Delicious and CiteULike; collaborative knowledge development through wikis (e.g., Wikipedia); creative works, such as podcasts, videocasts, blogs, and microblogs (e.g., Twitter, Blogger); content aggregation and organization, such as RSS (Really Simple Syndication) feeds and tagging tools; and remixing or mash-ups of content from different content providers into new forms, such as combining geographical data with transportation or crime data. Web 2.0

promotes users and their interconnections through the following affordances: (a) user-defined linkages between users and content (e.g., posting on others’ pages), (b) simple mechanisms to share multimedia content (e.g., blogs), (c) prominent personal profiling (e.g., displaying user preferences on customized profile pages), and (d) intertechnology applications, enabling interfaces with services and features on other sites, for example, sites that offer alternative designs for MySpace pages or widgets that plug information from one site into another (Cormode & Krishnamurthy, 2008). Of course, precise distinctions between Web 1.0 and Web 2.0 are elusive because in reality, technologies evolve over time, with newer iterations emerging from previous ones and some sites characterized by a blend of Web 1.0 and Web 2.0 features (Cormode & Krishnamurthy, 2008).

Conceptually, Web 2.0 seems to embody “knowledge” as “collective agreement” that “may combine facts with other dimensions of human experience, such as opinions, values, and spiritual beliefs” (Dede, 2008, p. 80). *Validity* of knowledge in Web 2.0 environments is established through peer review in an engaged community, and *expertise* entails understanding disputes and offering syntheses widely accepted by the community (Dede, 2008, p. 80). In other words, knowledge is decentralized, accessible, and co-constructed by and among a broad base of users.

Broadening Conceptualization of “Classrooms”

Web 2.0 technologies enable hybrid learning spaces that travel across physical and cyber spaces according to principles of collaboration and participation. Today, learners have more choices about how and where to spend their learning time (e.g., in online settings or in private, public, or home school options) than they did 10 years ago. Today’s youth are frequently creative, interactive, and media oriented; use Web 2.0 technologies in their everyday lives; and believe that more use of such technologies in school would lead to increased preparation and engagement (DeGennaro, 2008; Lenhart et al., 2008; Levin, Arafeh, Lenhart, & Rainie, 2002; Solomon & Schrum, 2007; Spires, Lee, Turner, & Johnson, 2008).

Yet Levin et al. (2002), in surveying 3,000 public school students, identified a “digital disconnect” (p. v) between students and their schools, with students claiming their teachers had not yet shifted their teaching to respond to the new ways students communicate and use the Web beyond their classrooms. Lenhart, Madden, Macgill, and Smith (2007) suggest that many teenagers actually prefer multichannel communication, such as text messaging, instant messaging, and communication through social network sites, to traditional e-mail and face-to-face communication. Indeed, 55% of online teenagers are using Web 2.0 technologies, such as social network sites, outside of school and visit their social network sites daily or several times a day, devoting an average of 9 hours per week to the network (Lenhart & Madden, 2007; National School Boards Association, 2007). A recent national survey of college undergraduates (ages 18 to 24) indicated similar trends (Salaway, Borreson, & Nelson, 2008). Through such sites, youth share media (e.g., photos, music, videos), exchange messages, form groups, request information, articulate or develop their personal connections, post or remix digital content, and create or comment in blogs (Lenhart & Madden, 2007). Contrary to most assumptions, youth’s online social activities are not devoid

of substantive intellectual activity. A survey from the National School Boards Association (2007) reported that students' online sharing in social network sites involves education and learning. Sixty percent of students surveyed reported using their social network sites to talk about education topics, and 50% reported talking specifically about schoolwork (National School Boards Association, 2007). DeGennaro (2008) describes an example of education-oriented Web 2.0 use by a group of students who persuaded their advisors to use instant-messaging technologies, leading to home-school activities in which students and advisors negotiated goals, co-constructed solutions, and "argued to learn" (p. 12). Despite the current lack of research, these and other emerging studies, and the emergent technological competencies in the field, indicate movement toward and projections of Web 2.0 activities with potential educational value.

Technological Competencies

The role of digital technologies in supporting learning and teaching typically has replaced or amplified nondigital activities; however, the field strives toward more transformative roles (Dede, 2007; Hughes, 2005; Warschauer, 2007; Windschitl, 1998), such as providing cognitive tools that share the cognitive burden of accomplishing tasks (Jonassen, 1996; Salomon, 1993). Computerization of routine tasks, such as mathematical calculations or the storing, sorting, and retrieving of information, frees learners' and teachers' minds for more demanding higher-order thinking. In the past, authors of desired technological competencies, in the form of standards, emphasized students' technology proficiencies, including operating technology tools and systems, communicating information, and making informed decisions (International Society for Technology in Education [ISTE], 1998). Today's graduating students face technological competencies that emphasize the capacity for innovation, leadership, multidisciplinary collaboration, collective problem identification, and resolution in a dynamic, digital environment (Hamel, 2007; ISTE, 2007; Partnership for 21st Century Skills, 2008). New standards emphasize the learner, his or her experiences and choices, and the cognitive, social, and cultural dimensions of how technology is used in various settings. For instance, recommended 21st-century competencies include creative and original multimedia work in complex project-oriented teams in which the problems, tasks, players, roles, and processes are in flux and often distributed across geographic and cultural distances (Dede, 2007; ISTE, 2007)—essentially transforming the work that individuals do and how and with whom they do it. To support and supervise students, teachers are expected to colearn, model, and facilitate the development of such competencies.

Conceptual Framework

Although youth yearn to use varied technologies in formal schooling, educational institutions remain largely grounded in the classical view of knowledge, expertise, and learning (Dede, 2007, 2008). This classical perspective stems primarily from disciplinary experts' determinations of what and how students should learn. Disciplinary experts shape curriculum standards, which in turn guide the development of instructional resources (e.g., textbooks or informational websites) and assessments (e.g., high-stakes tests). Still dominant is a view and use of the Web as

augmenting information retrieval rather than supplanting traditional resources and activities, despite the evolution in Web technologies, students' out-of-school habits and learning style preferences, and new desired competencies (Dede, 2008; Greenhow, 2006; Spires et al., 2008).

We as researchers and educators observe students engaging in formal, informal, and nonformal learning across a wide range of contexts and exercising considerable authority over how, when, and with whom they learn. Grounded in sociocultural activity and situated learning theories (Cole, 1996; Engeström, 1987; Greeno, 1989; Vygotsky, 1978), a *learning ecology* perspective (Barron, 2006; Bronfenbrenner, Kessel, Kessen, & White, 1986) might be most useful in helping education researchers to conceptualize, study, and bridge learning and teaching across the Web 2.0 spaces of home, school, work, and community. Barron (2006) defines a learning ecology as the "set of contexts found in physical or virtual spaces that provide opportunities for learning" (p. 195). Like the notions of *situated learning* and *cognitive apprenticeship* (Brown, Collins, & Duguid, 1989), which posit learning as located in contexts and relationships rather than merely in the minds of individuals, sociocultural and sociohistorical theories are based on the assumption that learning derives from participation in joint activities, is inextricably tied to social practices, and is mediated by artifacts over time. Such perspectives honor the contributions of macrolevel processes (i.e., community, societal) as well as microlevel perspectives (individual participants, groups) and the relationships between them (Greenhow & Belbas, 2007).

The notion of a learning ecology stipulates that (a) individuals are simultaneously involved in many settings, (b) individuals create learning contexts for themselves within and across settings, (c) the boundaries among settings can be permeable, and (d) interest-driven activities can span contextual boundaries and be self-sustaining given adequate time, freedom, and resources (Barron, 2006, pp. 199–201). For example, what children learn outside of school can shape what they learn in school as they seek out projects based on their interests. In turn, school projects can stimulate students' interest that can motivate them to seek more information, opportunities, and like-minded people with whom to learn on their own terms (Barron, 2004, 2006). Overall, learning can manifest itself across settings, and informal or formal crossing of boundaries might enhance learning.

If learners, teachers, and schools harness Web 2.0 for educational purposes, research is required to understand the technological, ethical, educational, and social practices across the life span, including technology use across a whole day (e.g., home, work, school, mobile devices). At the 2008 National Technology Leadership Summit, researchers and policy makers representing 20 educational organizations identified bridging youth's formal and informal learning with participatory media as a major objective facing future education research and practice (Bull et al., 2008; Greenhow, 2008).

Windschitl (1998) opened this conversation, and we believe it warrants continuation by asking, In what ways does Web 2.0 *now* support teaching and learning? In this article, we describe the contextual conditions in which students use the Web today and examine how the unique capabilities of Web 2.0 and youth's proclivities in using it influence learning and teaching.

We forefront two important themes focused on *learners*—*learner participation and creativity* and *online identity formation*—that we believe warrant a new wave of research that will focus on youth's everyday use of Web 2.0 technologies for learning in and outside of classrooms. We conclude by focusing on *education researchers* and provide insights on how Web 2.0 technologies may transform scholars' creativity, identities, and scholarship.

Learners' Participation and Creative Practices

In the past decade, many studies have conceptualized Web use in classrooms as an information repository and students as recipients rather than producers of knowledge. As Windschitl (1998) suggested, scholars have addressed research questions relating to Web 1.0 issues, such as Web access and selection and interpretation of information and media (Kuiper & Volman, 2008; Kuiper, Volman, & Terwel, 2005; Livingstone, Van Couvering, & Thumin, 2008). Past research examined students' online inquiry processes and reported their difficulties in finding information online and in discerning the truth or reliability of the information they found (Hoffman, Wu, Krajcik, & Soloway, 2003; Holscher & Strube, 2000; Jones, 2002; Kafai & Bates, 1997; Kuiper et al., 2005; Livingstone et al., 2008; Wallace, Kupperman, Krajcik, & Soloway, 2000). Fewer studies have focused on students' creation of multimedia content for the Web and their participation on the Web through multimedia artifacts they create and share (Buckingham, 2005). Among these are studies on computer-supported collaboration (Stahl, Koschmann, & Suthers, 2006) and "knowledge building" (Scardamalia & Bereiter, 2006, pp. 104–105) that have focused on collaboration and learner creation and co-evolution of digital artifacts in "knowledge-building" environments (pp. 104–105). Web 2.0 enhances the opportunities envisioned by these, and other, earlier works. With technical expertise now serving as less of a barrier, and expanded Web access and contexts for learning, Web 2.0's affordances of *interconnections*, *content creation and remixing*, and *interactivity* might facilitate an increased research interest in learners' creative practices, participation, and production—suggesting new ways of thinking about the digital-age competencies we seek to model and facilitate in a range of content areas.

The transformed Web described here is changing the way we as researchers and educators think about learners' participatory and creative practices with various Web 2.0 technologies, especially about what, how, with whom, and for what purposes learning occurs through such practices. For instance, Web 2.0 features allow learners to link up, create, consume, and share independently produced information, media, and applications on a global scale. Many features encourage interconnections among learners, allowing them to develop their networks and increase the number and range of people to consult for feedback or support. RSS allows updated information from Web pages to be aggregated in one place using RSS aggregator software. As updates happen in online social network sites or news sites, for instance, RSS feeds enable learners to stay more attuned to friends or world events, respectively, through the range of multimedia information posted. Electronic invitations, group subscriptions, and other network elements pushed to an individual user's account permit learners to identify new resources and people to track or invite into their knowledge base and to deepen relationships with existing contacts.

Another aspect of Web 2.0 is its capacity for content creation and "remixing" practices, in which a range of found or original online materials are cut, spliced, edited, reworked, and mixed into new creations. Graphics and text can be repurposed and rearranged, blurring the lines between information consumption and production and between individual and group authorship of expression in richly visual and social media. Of course, creating multimedia content is not necessarily the same as creating new knowledge, as in the case of wiki pages that synthesize a range of content but do little to generate meaningful patterns, compositions, or ideas not clearly present before, thereby advancing the state of knowledge in a field (Anderson & Krathwohl, 2001). Defining what counts as "valid or legitimate or desirable" forms of understanding and creativity in current contexts will certainly continue to be one of the challenges (Buckingham, 2005, p. 149).

A third aspect of Web 2.0 is interactivity—facilitated by features that do not require sophisticated technical expertise but allow users to publish, share, consume, and remix content. Blogs, wikis, and video-sharing, photo-sharing, and audio-sharing sites can engage students in promoting their works while also critically considering the works of others, including friends' works; mainstream "authorized" sources, such as *Newsweek*; and unsanctioned sources, such as political blogs. Many of these sources, for instance, can push information to students through an RSS feed before it is officially in print, as in the case of a *Newsweek* blog, and engage them in public dialogue on cutting-edge issues.

Taken together, the interconnections, creative capabilities, and interactivity of Web 2.0 offer learners initiation into a Web-based "participatory culture" (Jenkins, 2006) that has "low barriers to artistic expression and civic engagement, strong support for creating and sharing one's digital productions" (Jenkins, 2006, p. 3), a sense of social connections "or at least caring what other people think about what one has created" (Jenkins, 2006, p. 3), and a belief that contributions matter. Participatory culture might take the form of "affiliations," such as online communities centered on people's background, interests, connections, and media (e.g., Facebook or MySpace); creative self- or collective "expressions" (e.g., fan video making, mash-ups); "collaborative problem solving" (e.g., Wikipedia); and "circulations" (e.g., podcasting, blogging) (Jenkins, 2006, p. 1). Such opportunities might promote potentially richer opportunities to make learning more personally meaningful, collaborative, and socially relevant.

Research Directions

Research should continue examining learners' online inquiry practices (often referred to as *information literacy* or *media literacy*), especially how they navigate, understand, trust, and critically evaluate multiple types and sources of data. However, if we as researchers and educators seek to develop in all students the aforementioned digital-age competencies that prepare them for a knowledge-based global economy, cultivate their interest-driven activities, and help them shape a democratic culture, we ought to expand lines of research to focus on students' use of Web 2.0 for participation, invention, and knowledge building in and beyond school settings. Researchers are just beginning to inquire into young people's participation patterns and creative acts with newer Web technologies in formal and informal learning environments.

Currently, there is little published empirical work on the subject, and the studies that exist stem largely from fields outside education, such as sociology, anthropology, and new media and communication studies. However, we present a handful of recent projects to exemplify some of the questions that individuals should be asking in education fields.

Researchers associated with the International Youth Network (IYN) project at the University of California, Berkeley, have begun investigating questions regarding young people's participation and creative practices in a global online social network (Hull & Nelson, in press). Specifically, they are examining how a youth-designed Web-based social network evolves to address the needs, concerns, and values of its members and fosters intercultural knowledge and literacy development. These researchers examine the role that various forms and channels of communication—language, image, music, video, multimodal combinations—play in these processes (Hull & Nelson, in press). Their work builds on earlier investigations of youth's digital story creations and the social functions these served for traditionally underserved, disengaged students (Hull & Nelson, 2005). These researchers are part of the new literacies movement, a growing group of scholars who argue that literacy today is a necessarily social, "situationally specific" (Coiro, Knobel, Lankshear, & Leu, 2008, p. 5), and "multimodal, multimedial, dynamically changeable enterprise" (Hull & Nelson, in press, p. 6; see also Hull & Nelson, 2005; Kress, 2003). It is no longer feasible for anyone to be fully literate in every technology available through the Internet; digital literacy includes knowing how and when to use which technologies and knowing which forms and functions are most appropriate for one's purposes. Consistent with the ecological perspective (Barron, 2006), which views individuals as creating learning contexts for themselves within and across settings, the findings from the IYN project might move the research community closer to understanding how to facilitate learners' capacity to construct coherent meanings from the changing array of people, artifacts, and impressions they encounter in their everyday lives.

Similarly, the Digital Youth (DY) project (<http://digitallyouth.ischool.berkeley.edu>) is a 3-year ethnographic research project begun in late 2005 and carried out at the University of Southern California and the University of California, Berkeley, by an interdisciplinary team of researchers from anthropology, communication, psychology, sociology, computer science, engineering, and media studies. These DY researchers are studying youth's informal learning with digital media and how youth use digital media in their everyday lives (Ito et al., 2008). They argue that children's passion and creativity with digital media have been nurtured more by peer group sociability and play than by academic learning (Ito et al., 2008). The researchers aim to portray young people's innovation with digital media and the innovative cultures in which they are immersed outside of school (e.g., in local neighborhoods and in virtual places and networks, such as online games, blogs, and online interest groups; Ito et al., 2008). Findings from this work might help bridge the gap between in-school and out-of-school learning and inform our efforts to invigorate education and engage kids. For instance, Perkel (2008) traced teenagers' "copy-paste" literacy practices in repurposing and recycling HTML in the production of a MySpace profile. He argued that youth's participation in online social network sites and the creative "remix"

practices they are developing there actually suggest new ways of thinking about the social and technical aspects of literacy development. Projects like this might contribute to the understanding of how different sociotechnical contexts privilege different kinds of knowledge development among learners, from superficial to deep content understanding, to new perspectives on learning goals, and their interrelationships.

There are many productive avenues for education researchers who wish to understand and help shape this evolving field. The first set of questions might focus on *what learners do* with Web 2.0 technologies, such as the following: How and why do learners participate and create digital content in various learning spaces, including both formal and informal learning settings? What is the nature and depth of individual and distributed learning through participation and content creation in these Web 2.0 contexts? How do learners engage with others through artifact creation and sharing processes, and what is the nature of their interconnections? Challenges to pursuing these questions include building trust with research participants and developing methods of continually capturing and assessing the extent and quality of dynamic multimedial artifacts and interconnections. Benefits include deeper understandings of learners' products and practices and potential insights about how to support, document, and design more engaging, media-rich, expanded contexts for learning over time.

A second set of research questions could focus on *issues of equity in and access* to these experiences, such as the following: What are the barriers or enablers to content creation and participation using Web 2.0 technologies (e.g., skills, knowledge, and attitudes needed; tools and services used)? How do different groups of learners experience Web 2.0 participation, content creation, and knowledge building? How can teachers play a role in fostering digital participation and reducing disenfranchisement? Few researchers currently address the roles of teachers and schools in acknowledging, modeling, or facilitating learning through creative and participatory practices on the Web. The field needs projects that address stakeholders in the learning ecology surrounding youth today, including teachers, parents, administrators, and others brought into the learning exchange, such as the following: Do students' online creative expressions or participation patterns change how school staff think about the "content" and outcome expectations or assessments within formal schooling (e.g., reading and writing, civic engagement, scientific inquiry)? How can teachers build on learners' everyday experiences in Web 2.0-enabled contexts to engage them better in content area learning and prepare them for the future? How can teachers develop their professional knowledge through similar Web 2.0-enabled practices? Finally, a set of questions can focus on *building theory and corollary practice and policies*, such as the following: What is the educative value of learners' participation and creative practices? How do learners' activities suggest new theories, pedagogy, curriculum, or policies that help bridge learning in and out of school?

To complement research that examines these questions in naturally occurring Web 2.0 environments, the field of education also needs design-based research that seeks to develop Web 2.0-infused environments based on learning theories and concomitantly to test and evolve theory and design across multiple

iterations (Barab, 2006). Challenges to pursuing such questions and methods include coordinating research on participants across multiple settings, gaining access to such settings as needed for the research (e.g., homes, after-school hangouts, mobile technologies), and managing the sheer volume and variety of data that would result, to name a few. However, what we as researchers and educators learn about learning and human-technology infrastructure could be immense and could contribute to a more coordinated approach to infusing Web 2.0 technologies as part of an overall strategy for educational reform.

Learners' Online Identity Formation

When learners engage in cycles of creation and consumption as part of the participatory Web culture described above, they are simultaneously developing online identities, or "dynamic and shifting constructions and presentations of self" (Coiro et al., 2008, p. 526), which have implications for education. One's identity might evolve through social, virtual, material, and discursive practices and vary across social contexts, spaces, and purposes (Steinkuhler, 2008; Turkle, 1995). Today's youth experiment with different identities online through fan-fiction writing, multimedia representations of ideas, uses of different digital communication tools, role-plays, and immersion in virtual worlds, such as Quest Atlantis, Whyville, River City, and World of Warcraft (Barab, Thomas, Dodge, Carteux, & Tuzun, 2005; Kafai, 2008; Ketelhut, Dede, Clarke, Nelson, & Bowman, 2007; Steinkuhler, 2008).

Youth have long been forming their identities while being scrutinized by adults in public community spaces, such as schools, places of worship, and community centers. Traditional structures that assisted young people in shaping their identities, such as stable family relationships, regional and national culture, or physical hangouts (e.g., the mall, the burger joint, or the park), are not as influential as they once were (boyd, 2007). Today's students try out their identities through Web-enabled authorship in the form of home pages, blogs, and online social network site profiles.

Developing one's identity online is a relatively recent cultural process, aided by the features of the participatory Web. In one study, boyd (2007), an ethnographer and social media researcher, describes this process of initiation and acculturation in a social network site, MySpace.com. She explains how teenagers new to the site learn to assimilate, customizing the look of their online profiles to represent themselves and identify with their peers. Often, the results are animated, brightly colored Web pages covered with original artwork, photographs, and writing. She also notes that newcomers often struggle with the demands of socializing virtually. She identifies four aspects of self-presentation in such sites that differ from the processes of identity development offline: (a) persistence: speech is ephemeral but electronic text can be stored indefinitely; (b) searchability: a journal in a drawer is very different from putting thoughts in an environment where people can look for specific names and places; (c) replicability: electronic media make it very easy for others to duplicate and change what one or another has created; and (d) invisible audiences: one cannot tell who is online reading one's thoughts, and what is written can be read in a context other than that intended (p. 126). Similarly, new media scholar Suzanne Stern (2007) writes about identity development, describing how youth use

online authorship to work out their personal beliefs, challenge cultural assumptions, and navigate complex relationships. Stern notes that many young people recognize the value of online self-promotion among peers and others. In research on identity formation among high school students in a social network site, we found that some students used their social network to work out emotional situations, leading to increased academic productivity (Greenhow & Robelia, in press-b). Writing about their feelings allowed them to take apart an emotional issue or problem, garner advice from friends, and troubleshoot (Greenhow & Robelia, in press-a). Youth also seek out the cathartic benefits of online expression through art, music, or photography (Stern, 2007). The characteristics of new media (persistence, searchability, replicability, audience invisibility) present both educational benefits and risks that warrant educators' participation and guidance, because schools have always taken part in students' struggles to emerge from what Erikson (1968) termed the "identity vs. role confusion" stage of development. As youth increasingly connect with peers online, portraying their interests, talents, social connections, and personal issues through social network site profiles, blogs, mash-ups, and other multimedia forms, they need to understand and anticipate the potential consequences (positive and negative) of their online actions. Web 2.0 features enable potentially valuable formative experiences and social practices in the learning ecology, but they also open the door to potentially unproductive interactions, harmful public scrutiny, and threats to privacy that undermine learning.

Baird and Fisher (2005) and Barnes, Marateo, and Ferris (2007) argue that students come to their classrooms and campuses expecting to exert their online identities and leverage their online social networks to collaborate as part of the learning process. They assert that students are now seeing the Web as a pool of knowledge to which they can add and from which they can draw support. Contradicting traditional pedagogical models in which students submit their works to one authoritative source (the instructor) and receive feedback from that source, today's learners expect to participate in evaluating as well as in being evaluated and to share work and feedback among their peers. More than 70% of the parents surveyed in the National School Boards Association (2007) report believed that using social network sites would help students improve reading and writing skills, conflict resolution, and social skills. Communication scholars Ellison, Steinfield, and Lampe (2007) studied college students' use of Facebook.com, finding that intense Facebook use correlated with learners' sense of increased social belonging, and it is well established that learners who feel socially connected to their communities perform better academically (e.g., Tinto, 1998; Zhao & Kuh, 2004).

As learners engage in more Web 2.0 technology use that naturally leads to identity exploration and development, many have come to recognize the value of simultaneously developing digital citizenship skills. Such skills prepare online users to practice safe and responsible use of technology and exhibit a positive attitude toward technology use that supports safe collaboration, learning, and productivity (ISTE, 2007; Partnership for 21st Century Skills, 2008). Drotner (2007) asserts that "young people's digital practices promise the formation of competencies that are absolutely vital to their futures, in an economic, social and cultural

sense” (p. 167). She argues that discussion of Internet use in schools needs to extend beyond teaching technical skills to encompass the skills and ethical issues surrounding activities that are currently and predominantly restricted to youth’s leisure time, such as texting, blogging, editing images and sound, circulating files through mobile phones, and gaming. She notes that these activities challenge the technological skills being taught in schools and demand the attention of educators.

However, many K–12 schools choose to block and ignore the existence of popular social network sites and other Web technologies on school networks (boyd & Ellison, 2007; Jenkins, 2006). Schools have an opportunity to help students recognize both the positive and negative aspects of how online media differ from more traditional forms of expression. We are not necessarily advocating integration of all Web 2.0 technologies into school-based learning. Although some Web 2.0 use might be appropriate in certain situations, we encourage conversations that engage students in metadiscussions of their digital practices in and out of schools, helping learners become more aware of the affordances of different kinds of online behaviors for developing competencies we as educators value (Lewis & Fabos, 2005). The National School Boards Association (2007) report recommends that school leaders explore Web 2.0 sites for themselves to better understand what students are doing outside of school. We advocate similar exploration by all school staff.

Research Directions

As learners use Web technologies more often and across their life contexts (e.g., home, school, work, mobile devices), they naturally explore aspects of their identities through shifting contexts and roles. Interdisciplinary research is warranted if we wish to better understand issues related to youth’s online identity development as well as the possible risks and benefits of identity development in online contexts.

First, research can focus on questions relating to *youth’s online identities*. Questions can include the following: How are today’s learners trying on and crafting their identities online? How do learners develop their identities in the content areas as writers, scientists, artists, and citizens, and how do they engage various features of Web 2.0 to do so? Learners’ online representations, connections, and creations might reveal important information about them. Thus researchers might ask, What is the nature of the digital dossiers that learners create? What do their digital self-presentations convey about them as learners and individuals? Finally, researchers might look inward to ask, What kinds of modeling and scaffolding should we as educators or designers provide to help learners engage in this process? Taking online identities into account, and considering learners as *multiple selves*, we as educators and researchers might push the boundaries of our own conceptual frameworks to identify how these selves interact and shape learning in the myriad settings that youth currently inhabit.

Second, research should focus on the *possible risks and benefits of emergent online identity development*. A set of questions might address the risks and benefits related to education and learning, such as the following: What are the educational benefits and risks of learners’ self-presentation in these Web-enabled contexts? Do young people balance the need for risk-taking,

role-playing, and creativity with the need for integrity and authenticity in their online experiences, and if so, how? Other questions could focus on the risks and benefits related to youths’ online processes while engaging in identity development, such as the following: How do teachers educate learners to negotiate different online public spaces and to ascertain what information should be kept private? In what ways can learners understand and enact digital citizenship while also supporting their freedom to experiment and speak freely online? What types of modeling, facilitation, and assessment are best for developing desired digital competencies? Challenges to exploring such questions include variation in Internet use policies (e.g., approaches to privacy, copyright, and autonomy) in institutional settings that limit the researcher’s ability to examine cross-context relationships and our own naïveté if we as researchers have not established a virtual presence for ourselves.

Transforming Scholarship With Web 2.0

Cultivating Academic Lives Online and Social Scholarship

Participatory Internet technologies not only change the way youth learn in and out of school; they have the potential to change the way academics engage in scholarship. One reason Web 2.0 technologies are not widely integrated in PreK–12 and graduate education is the lack of modeling by instructors. Bull et al. (2008) argue that instructors’ lack of knowledge, combined with a lack of research-based best practices, constrains instructors’ abilities to bridge between learners’ engagement with Web 2.0 uses outside of school and formal Web 1.0 classroom-based lessons. Such a lack of knowledge prevents both emerging and senior scholars from building “serious online lives” (Lankshear, 2007, p. 12) through the kinds of participant activity, most likely collaborative in nature, that Lankshear (2007) claims would allow scholars to distinguish among hype, fallacies, and the appropriate and educative potential of these new participatory technologies.

“Go to my Delicious and then we’ll talk,” a professor told a student asking to meet with her. To many, this directive appears perplexing. Go *where*? Delicious (<http://delicious.com/>) is a social bookmarking service that in its simplest appearance is a website of hot-linked bookmarks (similar to what is contained in an Internet browser’s bookmarks). However, Delicious also functions as a central, networked “place” on the Internet where an individual’s bookmarks, tags (similar to keywords), and short critiques or summaries of important information reside and can be accessed on any networked computer in the world. In Delicious, one can build a community of friends and colleagues who can examine, share, and observe tag patterns across bookmarked material. The professor, in this example, has begun to cultivate a scholarly life online through a Delicious site on which she has compiled vast amounts of multimedia information on discipline-specific topics. By consulting Delicious, the student is simultaneously preparing academically for a meeting with his or her professor while also watching her model the integration of participatory Internet technologies in her teaching, advising, and research practices. At the same time, the professor is developing her own online identity. Soon, she might become known for her bookmark collection and interpretations of texts and resources on a particular subject(s). Such a reputation develops through

ever-expanding networks within the system that allow Delicious users to see and track other users' public bookmark collections.

This example begins to introduce *social scholarship*, a new practice being discussed and debated in several disciplines, especially library sciences (Cohen, 2007; Taraborelli, 2008). Social scholarship capitalizes on Web 2.0 affordances to evolve the ways in which scholarship is accomplished in academia. It connects traditional formal scholarship practices (such as creating a peer-reviewed, print-based journal article) with more informal, social Internet-based practices (such as hosting an online video or audio conference discussion about a journal article; for an example, see the journal *Innovate* at <http://innovateonline.info/> and click on the "Webcasts" menu). Cohen (2007) views social scholarship as embodying values such as "openness, conversation, collaboration, access, sharing, and transparent revision" (para. 1). Social scholarly practices seek to apply, build on, and archive the collective intelligence to transform the practice and consumption of traditional print-based research. As the earlier Delicious example demonstrated, Web 2.0 tools exist that might allow academics to reflect on and reimagine what they do as scholars. Such tools might positively affect—even transform—research, teaching, and service responsibilities—only *if* scholars choose to build serious academic lives online, presenting semipublic selves and becoming more invested in and connected to the work of their peers and students. Next, we describe many Web 2.0 technologies, and examples when available, that allow scholars to engage socially and collaboratively online to transform scholarship.

Several tools, similar to Delicious, allow researchers to compile, annotate, recommend, and share resources, such as websites, journal articles, books, and contacts. CiteULike (see example at <http://www.citeulike.org/user/davidbrake>), an academic-oriented social bibliography site, allows one to save books and articles online. Features allow users to examine other users' bibliographies as well as view *tag* and *author clouds*, a cloudlike illustration representing the most frequent words as visually larger and bolder. For example, in CiteULike, David Brake's most-cited author is Lois Scheidt, as evidenced by the name's large font size in the author cloud. Once logged into the CiteULike community, one can "watch" as Brake adds to his entire library or to tagged sections of it using RSS technology. As users add articles or books to their online libraries, the individual citations in all bibliographies dynamically update. All members, therefore, can monitor who in the community has added new resources as indicated by a number and user ID, which appear at the end of each reference. For example, at the time of writing, 23 people and nine groups have cited Wenger's (1998) *Communities of Practice*. Through such dynamic referencing, researchers might become aware of new information, informally confirm the importance of scholarship in their bibliographies, and even build relationships with others who cite similar materials.

Technically, the tag and author clouds in Delicious and CiteULike exemplify the importance of metadata. Taraborelli (2008) forecasts how metadata analysis and ranking might change, or at least create another lens on peer review processes, potentially ushering in an important "soft peer review" (p. 25) based on how much an author's work is cited, tagged, or reviewed online. For instance, as a supplement to traditional peer review of print-based journal manuscripts, these technologies allow each

online reader to rate or rank, tag, and annotate materials. Because online, interactive readers are likely to be highly interested in the topic, these online reviews and annotations might provide potentially valuable additional insights on scholarship's impact and applicability to the field, as compared with manuscript peer review and Citation Index data.

Building an online bibliography, such as Delicious, can simultaneously result in online identity building. Certainly, academics have reputations within their colleges, universities, and academic communities. Now, such identities can be broadened by sharing oneself in online spaces. In doing so, myriad relationships might emerge that change the social settings and formal learning spaces in which the academic usually engages. The effect on one's academic self might be greater interdisciplinary leanings, an increased academic role (e.g., impact on undergraduate and graduate students), and a wider community role (e.g., impact on business or industry). In essence, the academic who uses participatory Internet technologies to her or his advantage also capitalizes on the learning ecology perspective, bridging scholarship and advocacy well beyond traditional, formal university spaces.

Free and accessible Web 2.0 technologies as well as licensed software also support communal action. For instance, Zotero (<http://www.zotero.org>) is a freeware academic bibliography program that, once installed, is located in the computer's Web browser. Zotero allows compiling of academic citations from library databases but also archives anything on the Internet, such as websites, blog posts, wiki entries, and white papers. Although currently it is designed for individual users, Zotero's developers are working to expand its capabilities to support collaborative, multiuser bibliographies. CiteLine (<http://citeline.mit.edu/>) is a tool that already facilitates online publishing, sharing, and interaction with bibliographies and citation collections that might be collected in various programs, such as in EndNote or Zotero, by importing BibTex formatted data. EndNote has developed EndNote Online, another licensed product to allow one's bibliographies to be available online, and Connotea (<http://www.connotea.org/>) is another emerging online bibliography program. These tools provide immediate, ubiquitous, and semipublic access (based on the user's sharing preferences) to the academic's knowledge base that, traditionally, has been largely contained in one's brain, in filing cabinets, or in self-contained computer software. The key to these emerging, open, scholar-oriented technologies is that the expertise usually embodied in one's publications, teaching, and presentations now becomes part of a much larger, collaborative, and dynamically updating online knowledge base.

Web 2.0 technologies also support dissemination, adaptations, and conversations about individual scholarship. The Massachusetts Institute of Technology's (MIT's) open courseware movement (<http://ocw.mit.edu/OcwWeb/>) was highly touted in academia as a transformative, almost incomprehensible phenomenon, as many questioned why professors would want to share or give away their syllabi and instructional approaches. With this single step, MIT enacted the qualities of social scholarship, such as openness, conversation, access, sharing, and transparent revision. Similarly, academics are now creating podcasts, vodcasts, or coursecasts of teaching, conference presentations, consulting activities, and even films (Woo, 2008). These can be shared through blogs, wikis (e.g., <http://wikipedia.org>), YouTube

(<http://youtube.com>), TeacherTube (<http://teachertube.com>), or other media-sharing tools. Yet all control of one's intellectual property is not lost, as Creative Commons (<http://creativecommons.org>) has developed tools that "let authors, scientists, artists, and educators easily mark their creative work with the freedoms they want it to carry" (Creative Commons, n.d., para 1). These tools encourage legal sharing, remixing, and reuse of online digital materials. With advances in Web 2.0 technology, we believe academia needs to expand the conventional view that sharing scholarship occurs only through print-based media, such as articles and books; through face-to-face conference presentations and keynotes; and through courses.

Web 2.0 has also expanded the academic's ability to cultivate social and professional connections and to potentially build and maintain larger networks for catalyzing interdisciplinary collaborations, multisite research, and interinstitutional partnerships. Individuals can set up the more casual and social Facebook accounts (<http://facebook.com>) and decide whether to add only colleagues or include students and others. A more professionally focused social network is LinkedIn (<http://linkedin.com>), where the résumé or curriculum vitae is a focal point. Many create their own social network using free software, such as Ning (<http://ning.com>) or Elgg (<http://elgg.org/>), to support special interest groups. For example, a special interest group in the American Educational Research Association hosted a preconference book discussion on Ning. Second Life (SL), which can be found at <http://secondlife.com>, also functions as a social network, but in SL, users create a virtual persona to represent themselves. Many universities and organizations have virtual land in SL. For example, the ISTE hosts frequent events at the virtual campfire ring, such as an open discussion of a Public Broadcasting Service documentary, *Where We Stand: America's Schools in the 21st Century*.

These Web 2.0 technologies are opening up educative outlets for scholarship among communities of people—academics can choose to ignore the current culture or attempt to build an online network of resources, colleagues, and authorship. Only by doing the latter is it possible to distinguish authoritatively between the hype and the potential of Web 2.0 technologies. In the process, academics can model lifelong learning by identifying effective uses of technology for educative purposes, building new identities and connections, and sharing scholarship with a wider audience than imaginable with traditional scholarship.

An Expanding Research Tool Kit and Emerging Ethical Issues of Tool Use

Fetterman (1998, 2002) acknowledged the role for emerging Web technologies in education research and instruction, ultimately emphasizing Web-based tools that had stood the test of time, including Web surveys, digital photography, voice recognition, file sharing, videoconferencing, Web chats, and digital movies. Web surveys, still very popular and increasingly easy to use, now provide immediate publishing capabilities so real-time results can be shared with participants. Google Forms (in GoogleDocs; see <http://docs.google.com/>), which allows production of a survey with a limited set of question types, immediately pushes survey responses into a Google spreadsheet that can be published on the Internet. We anticipate more online survey tools to incorporate mechanisms for discussion of such results,

much like social networking sites that offer forms and survey widgets along with built-in discussion, text, and comment features.

Currently, RSS technologies allow researchers to be updated upon release of new research and funding opportunities. Most library databases (e.g., Education Full Text and PsycInfo) allow users to set up an RSS feed based on search criteria. In that way, users will be alerted to any new research articles that fit their interests. Similarly, many funding agencies and foundation databases also have RSS capabilities. College or research groups could aggregate all the RSS funding and research literature feeds on a certain topic into a dynamic website that is available to all members.

Fetterman (2002) also described digital photography and movies as research tools, but technological advances easily make these research participant tools. For example, the ubiquity of phones with camera or movie capabilities can be incorporated as a resource for data collection, creating situations in which study participants can easily take photographs or movies (e.g., Cappello & Hollingsworth, 2008; Marquez-Zenkov & Harmon, 2007) to document events. Flickr (<http://www.flickr.com>) allows private groups in which photos and videos can be uploaded and tagged. Thus research participants could upload applicable files into a private group. Participant tagging could facilitate initial coding and organization of this type of data as well as allow for initial pattern matching (Yin, 1994, 2002). Ethically, principal investigators would need to determine if participants should see each other's contributions; if not, creation of semiprivate repositories, accessible only to the participant and research team, would be appropriate and still allow tagging. Investigators could aggregate data at a later time after eliminating participant access. Ownership of the images would need to be determined, as the students or participants might develop great affinity with their products and become uncomfortable with their photographs' projected research uses. Finally, researchers should consider cultural implications of photography among youth, as some cultures are uncomfortable with photography, and others might worry about public displays or unknown uses. Sarroub (2005) discusses how Yemeni American girls refused to have their photos taken, as they were unsure how boys or others might use them. Although researchers should take actions to honor cultural or religious beliefs, it might lead to underrepresentation of certain cultural groups, leading to skewed data or overrepresentation of other groups.

Researchers could gather data from individuals' social networks, such as Facebook, MySpace, or others (e.g., Livingstone, 2008). Access to status updates, wall postings, photos, and other widget information might be of interest to investigators across many disciplines. Gathering such data is possible if participants provide investigators with access (i.e., add the investigator as a friend or show the profile to the investigator, as in Livingstone's 2008 study). However, with the former approach, the participants' other online friends might quickly notice the investigator's presence, which could have an undue influence on the participants' normal social network activity. Investigators could create "fake" social networking identity information to match the participant age and social background (while maintaining their real identities and consent procedures with the participant). Although this approach might reduce the impact the investigator has on the participant and research context, it might not be ethically wise to misrepresent oneself.

This previous example is just one that reveals the massive volume of public, semiprivate, and private online data archived and available through various Web 2.0 technologies, such as social network sites, YouTube.com, Flickr.com, blogs, podcasts, and map mash-ups; yet ever-present ethical concerns must also be considered. Publicly available online data allow one to code quantitatively and qualitatively and analyze such data, along with other data sources, but should one do so? Ethically, who owns and has the right to use the data? For example, a researcher interested in teacher candidate reflections can collect and analyze publicly posted teacher reflections on their blogs. But ethical questions arise: Can the researcher use the blog entries without informed consent? Are these users in a vulnerable population because of a possible lack of technological knowledge, making them unaware that their reflections are publicly available? Because of the data's public status, do researchers need to safeguard the identity of the participants? At the outset of any study situated in online environments or mediums, researchers (especially novice researchers) should consider how many data are necessary to answer the research questions. Just one data source (e.g., online discussion posts in an online community or social network of just a few people) can quickly yield thousands of data entries requiring coding and analysis. How many data are necessary? Ess and Buchanan (2008) have begun to describe many of these ethical dilemmas and concerns with both public and private online data. They also describe some precedents for dealing with such dilemmas, providing a useful resource for institutional review boards faced with evaluating new research methods.

Conclusions

In this article, we have discussed changes in the nature of the Web, in the technological competencies and values we want learners to develop, and in our conceptualization of "classrooms" as learning takes place across physical and cyber spaces, providing learners with an array of choices about the substance and location of their experiences. New affordances have led to learners using the Web in ways that necessitate shifts in research: It has become necessary for researchers to explore the Web's current and potential roles in education.

We contend that a stronger research focus on students' everyday use and learning with Web 2.0 technologies in and outside of classrooms is needed. Specifically, we advocate a focus on *learners*—learner participation and creativity and online identity formation—and how these intersect with, support, or suggest desired competencies, teaching practices, and policies. We also advocate education research that attends not only to what learners do with Web 2.0 technologies and the online identities they are developing but also to issues of equity, access, educational benefits, and risks that shape future research designs and technological and pedagogical innovation. Such research will not be easy, as it requires access to spaces that heretofore either did not exist or were perceived to be of little consequence to learning and thus ignored. New protocols will need to be established to ease the challenge of gaining access and consent.

Furthermore, this article is a call to education researchers to grasp some of these changes and cultivate online lives (and identities) as part of their own professional development. This would involve modeling, mentoring, and engaging other researchers in

practices of social scholarship as well as being colearners of Web-enabled scholarly tools and participants in collective problem solving regarding the ethical dilemmas that Internet research raises. Perhaps most important is the potential for researchers to employ social scholarship to aggregate more quickly research that addresses key policy questions and to reduce the time to dissemination, thereby putting research into the hands of policy makers, leaders, and the general public more effectively.

To accomplish what we outline in this article, we expect education researchers will become more interdisciplinary, maintaining awareness of the topics, frameworks, and techniques that characterize related research in other disciplines; openness to sharing and learning from research outside their domains; and collective reflection on their practices. HASTAC, a humanities, arts, science, and technology collaborative online since 2006 (<http://www.hastac.org/>), epitomizes such interdisciplinary practices.

We opened with the question in our title, "What path should we take *now*?" In closing, we would like to speculate about what the Web might develop into and how its pathway might further shape the field of education research. Two emergent technologies, cloud computing and social operating systems, will likely influence both education and research in the next decade. Increased cloud computing software, run over the Internet rather than locally on a user's computer, will likely intensify the participatory and creative practices discussed in this paper. Katz (2008) describes how cloud computing might revolutionize educational and research practices as students, researchers, and professors at different institutions can share access to specialized software, such as 3-D modeling programs, and tap into supercomputing power over the Internet. With cloud computing, practices once reserved for large, heavily funded university projects now become possible across all postsecondary institutions. Cloud computing could also be used in disciplines typically underfunded for research, such as the humanities, fostering greater interdisciplinarity and stimulus for innovation. We see evidence of cloud computing among our students, who already increasingly tap Google's suite of Web-based applications (e.g., GoogleDocs, Google spreadsheets, Google calendar) to plan remotely or work together online, leading us to develop new evaluation and assessment practices.

In social operating systems, the emphasis on data and information is equal to or replaced by an emphasis on creating, developing, and sustaining human relationships (Katz, 2008; New Media Consortium [NMC], 2008). Technology executives predict this next wave of social networking, social operating systems, will move technology systems away from restricting users to walled-off membership in a few sites (e.g., Facebook) toward a more open and flexible sharing among numerous niche communities (Helft & Stone, 2007; NMC, 2008; Stone, 2007). These social operating systems will enable students, teachers, and researchers to make visible their "social graph," or the network of people they know, are related to, or work with independent of any given address book or networking system. Such tools might be especially useful for helping students develop domain knowledge and become inducted into the practices that characterize their fields of study, as this example from the *Horizon Report* illustrates:

Students working on research papers often do not fully realize what it means to be a scholar. Of the network of activities that scholars are involved in—writing, researching, interacting with peers and colleagues, presenting at conferences—only a small part is apparent to a student doing research. Every idea, paper, experiment, and artifact is, in reality, attached to a person or group of people who helped bring it about. Imagine the impact of tools that place those people and relationships at the center of any research inquiry: concepts clearly linked to people; connections between those people and others clearly indicated; a much more complete picture of the topic would emerge, more quickly than is possible with current tools. (NMC, 2008, p. 26)

We believe that these emergent technologies hold great promise and challenges for transforming education research and practice. Amid the hype and speculation, education researchers need to keep educational aims in the foreground yet remain transparently curious about manifestations of learning beyond what we currently know. Emerging research and institutional practices in and outside the field highlight the possibilities and pitfalls of Web 2.0 for teaching and learning. We need to pursue understanding of those opportunities and challenge existing barriers that prevent us (scholars, teachers, administrators, students, and families) from taking a step toward discovery.

REFERENCES

- Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). *A taxonomy for learning, teaching and assessing: A revision of Bloom's taxonomy of educational objectives*. New York: Longman.
- Baird, D. E., & Fisher, M. (2005). Neomillennial user experience design strategies: Utilizing social networking media to support "always on" learning styles. *Journal of Educational Technology*, 34(1), 5–32.
- Barab, S. (2006). Design-based research: A methodological toolkit for the learning scientist. In R. K. Sawyer (Ed.), *Cambridge handbook of the learning sciences* (pp. 153–170). Cambridge, UK: Cambridge University Press.
- Barab, S., Thomas, M., Dodge, T., Carteaux, R., & Tuzun, H. (2005). Making learning fun: Quest Atlantis, a game without guns. *Educational Technology Research and Development*, 53, 86–107.
- Barnes, K., Marateo, R. C., & Ferris, S. P. (2007, April/May). Teaching and learning with the net generation. *Innovate*, 3(4). Retrieved September 24, 2008, from <http://www.innovateonline.info/index.php?view=article&id=382>
- Barron, B. (2004). Learning ecologies for technological fluency: Gender and experience differences. *Journal of Educational Computing Research*, 3(1), 1–36.
- Barron, B. (2006). Interest and self-sustained learning as catalysts of development: A learning ecologies perspective. *Human Development*, 49, 193–224.
- boyd, d. (2007). Why youth ♥ social network sites: The role of networked publics in teenage social life. In D. Buckingham (Ed.), *The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning: Youth, identity and digital media* (pp. 119–142). Cambridge, MA: MIT Press. Retrieved October 9, 2008, from <http://www.mitpressjournals.org/toc/dmal/-/6?cookieSet=1>
- boyd, d. m., & Ellison, N. B. (2007). Social network sites: Definition, history, and scholarship. *Journal of Computer-Mediated Communication*, 13(1), article 11. Retrieved October 9, 2008, from <http://jcmc.indiana.edu/vol13/issue1/boyd.ellison.html>
- Bronfenbrenner, U., Kessel, F., Kessen, W., & White, S. (1986). Toward a critical social history of developmental psychology. *American Psychologist*, 41, 1218–1230.
- Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18(1), 32–42.
- Buckingham, D. (2005). *The media literacy of children and young people: A review of the literature*. London: Ofcom.
- Bull, G., Thompson, A., Searson, M., Garofalo, J., Park, J., Young, C., & Lee, J. (2008). Connecting informal and formal learning: Experiences in the age of participatory media. *Contemporary Issues in Technology and Teacher Education*, 8(2). Retrieved October 9, 2008, from <http://www.citejournal.org/vol8/iss2/editorial/article1.cfm>
- Cappello, M., & Hollingsworth, S. (2008). Literacy inquiry and pedagogy through a photographic lens. *Language Arts*, 85, 442–449.
- Cohen, L. (2007, April 5). *Social scholarship on the rise*. Retrieved October 7, 2008, from http://liblogs.albany.edu/library20/2007/04/social_scholarship_on_the_rise.html
- Coiro, J., Knobel, M., Lankshear, C., & Leu, D. (2008). Central issues in new literacies and new literacies research. In J. Coiro, M. Knobel, C. Lankshear, & D. Leu (Eds.), *Handbook of research on new literacies* (pp. 1–21). New York: Lawrence Erlbaum.
- Cole, M. (1996). *Cultural psychology: A once and future discipline*. Cambridge, MA: Harvard University Press.
- Cormode, G., & Krishnamurthy, B. (2008). Key differences between Web 1.0 and Web 2.0. *First Monday*, 13(6). Retrieved October 5, 2008, from <http://www.uic.edu/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/2125/1972>
- Creative Commons. (n.d.). *What is Creative Commons?* Retrieved September 17, 2008, from http://wiki.creativecommons.org/images/3/35/Creativecommons-what-is-creative-commons_eng.pdf
- DeBell, M., & Chapman, C. (2006). *Computer and Internet use by students in 2003* (NCES 2006–065). Washington, DC: U.S. Department of Education, National Center for Education Statistics.
- Dede, C. (2007). Reinventing the role of information and communication technologies in education. In L. Smolin, K. Lawless, & N. C. Burbules (Eds.), *Information and communication technologies: Considerations of current practices for teachers and teacher educators: 106th Yearbook of the National Society for the Study of Education* (Part 2, pp. 11–38). Malden, MA: Blackwell.
- Dede, C. (2008, May/June). A seismic shift in epistemology. *EDUCAUSE Review*, pp. 80–81. Retrieved March 4, 2009, from <http://net.educause.edu/ir/library/pdf/ERM0837.pdf>
- DeGennaro, D. (2008). Learning designs: An analysis of youth-initiated technology use. *Journal of Research on Technology in Education*, 41(1), 1–20.
- Drotner, K. (2007). Leisure is hard work: Digital practices and future competencies. In D. Buckingham (Ed.), *The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning: Youth, identity and digital media* (pp. 167–184). Cambridge, MA: MIT Press. Retrieved October 6, 2008, from <http://www.mitpressjournals.org/toc/dmal/-/6?cookieSet=1>
- Ellison, N., Steinfield, C., & Lampe, C. (2007). The benefits of Facebook "friends": Exploring the relationship between college students' use of online social networks and social capital. *Journal of Computer-Mediated Communication*, 12(4), article 1. Retrieved July 30, 2007, from <http://jcmc.indiana.edu/vol12/issue4/ellison.html>
- Engeström, Y. (1987). *Learning by expanding: An activity-theoretical approach to developmental research*. Helsinki: Orienta-Konsultit Oy.
- Erikson, E. (1968). *Identity, youth and crisis*. New York: Norton.
- Ess, C., & Buchanan, E. (2008). Internet research ethics: The field and its critical issues. In K. Himma & H. Tavani (Eds.), *Information and computer ethics* (pp. 273–292). Hoboken, NJ: Wiley.

- Fetterman, D. M. (1998). Webs of meaning: Computer and internet resources for educational research and instruction. *Educational Researcher*, 27(3), 22–30.
- Fetterman, D. M. (2002). Web surveys to digital movies: Technological tools of the trade. *Educational Researcher*, 31(6), 29–37.
- Fox, S., Anderson, J. Q., & Rainie, L. (2005). *The future of the Internet*. Washington, DC: Pew Charitable Trusts. Retrieved September 29, 2008, from http://www.pewinternet.org/pdfs/PIP_Future_of_Internet.pdf
- Greenhow, C. (2006). *From blackboard to browser: An empirical study of how teachers' beliefs and practices influence their use of the Internet in the classroom and are influenced by the Internet's affordances*. Unpublished doctoral thesis, Harvard University, Cambridge, MA.
- Greenhow, C. (2008). Commentary: Connecting formal and informal learning in the age of participatory media: A response to Bull et al. *Contemporary Issues in Technology and Teacher Education*, 8(3). Retrieved September 25, 2008, from <http://www.citejournal.org/vol8/iss3/editorial/article1.cfm>
- Greenhow, C., & Belbas, B. (2007). Using activity-oriented design methods to study collaborative knowledge-building in e-learning courses. *International Journal of Computer-supported Collaborative Learning*, 2, 363–391.
- Greenhow, C., & Robelia, B. (in press-a). Informal learning and identity formation in online social networks. *Learning Media and Technology*.
- Greenhow, C., & Robelia, B. (in press-b). Old communication, new literacies. Social network sites as social learning resources. *Journal of Computer-Mediated Communication*.
- Greeno, J. (1989). The situativity of knowing, learning, and research. *American Psychologist*, 53, 5–26.
- Hamel, G. (2007). *The future of management*. Cambridge, MA: Harvard Business School Press.
- Hartley, K., & Bendixen, L. D. (2001). Educational research in the Internet age: Examining the role of individual characteristics. *Educational Researcher*, 30(9), 22–26.
- Helft, M., & Stone, B. (2007, October 31). Google and friends to gang up on Facebook. *The New York Times*. Retrieved September 25, 2008, from <http://www.nytimes.com/2007/10/31/technology/31google.html>
- Hoffman, J. L., Wu, H.-K., Krajcik, J. S., & Soloway, E. (2003). The nature of middle school learners' science content understanding and use of on-line resources. *Journal of Research on Science Teaching*, 40, 323–346.
- Holscher, C., & Strube, G. (2000). Web search behavior of Internet experts and newbies. *Computer Networks: The International Journal of Computer and Telecommunications Networking*, 33, 337–346.
- Horrigan, J. B. (2008). *Home broadband adoption 2008*. Washington, DC: Pew Charitable Trusts. Retrieved September 29, 2008, from http://www.pewinternet.org/pdfs/PIP_Broadband_2008.pdf
- Hughes, J. E. (2005). The role of teacher knowledge and learning experiences in forming technology-integrated pedagogy. *Journal of Technology and Teacher Education*, 13, 277–302.
- Hull, G., & Nelson, M. E. (2005). Locating the semiotic power of multimodality. *Written Communication*, 22, 224–262.
- Hull, G., & Nelson, M. E. (in press). Literacy, media, and morality: Making the case for an aesthetic turn. In M. Prinsloo & M. Baynham (Eds.), *The future of literacy studies*. Houndmills, UK: Palgrave Macmillan.
- International Society for Technology in Education. (1998). *National educational technology standards for students (NETS-S)*. Eugene, OR: Author.
- International Society for Technology in Education. (2007). *The ISTE national educational technology standards (NETS-S) and performance indicators for students*. Retrieved on September 26, 2008, from http://www.iste.org/Content/NavigationMenu/NETS/ForStudents/2007Standards/NETS_for_Students_2007_Standards.pdf
- Ito, M., Horst, H., Bittanti, M., boyd, d., Herr-Stephenson, B., Lange, P. G., et al. (2008). *Living and learning with new media: Summary of findings from the Digital Youth Project*. White paper, the John D. and Catherine T. MacArthur Foundation Reports on Digital Media and Learning. Retrieved January 30, 2009, from <http://digitalyouth.ischool.berkeley.edu/report>
- Jenkins, H. (2006). *Confronting the challenges of participatory culture: Media education for the 21st century*. White paper for the MacArthur Foundation. Retrieved on July 1, 2008, from www.digitallearning.macfound.org
- Jonassen, D. H. (1996). *Computers in the classroom: Mindtools for critical thinking*. Englewood Cliffs, NJ: Prentice-Hall.
- Jones, B. D. (2002). Recommendations for implementing Internet inquiry projects. *Journal of Educational Technology Systems*, 30, 271–291.
- Kafai, Y. (2008). Synthetic play: Girls and boys gaming together and apart in teen virtual worlds. In Y. Kafai, C. Heeter, J. Denner, & J. Sun (Eds.), *Beyond Barbie and Mortal Kombat: New perspectives on gender and computer games* (pp. 60–85). Cambridge, MA: MIT Press.
- Kafai, Y., & Bates, M. J. (1997). Internet Web-searching instruction in the elementary classroom: Building a foundation for information literacy. *School Library Media Quarterly*, 25, 103–111.
- Katz, R. (2008). *The tower and the cloud: Higher education in the age of cloud computing*. Retrieved October 10, 2008, from <http://net.educause.edu/ir/library/pdf/PUB7202.pdf>
- Ketelhut, D. J., Dede, C., Clarke, J., Nelson, B., & Bowman, C. (2007). Studying situated learning in a multi-user virtual environment. In E. Baker, J. Dickieson, W. Wulfbeck, & H. O'Neil (Eds.), *Assessment of problem solving using simulations* (pp. 37–58). Mahwah, NJ: Lawrence Erlbaum.
- Kress, G. (2003). *Literacy in the new media age*. New York: Routledge.
- Kuiper, E., & Volman, M. (2008). The Web as a source of information for students in K–12 education. In J. Coiro, M. Knobel, C. Lankshear, & D. Leu (Eds.), *Handbook of research on new literacies* (pp. 241–266). New York: Lawrence Erlbaum.
- Kuiper, E., Volman, M., & Terwel, J. (2005). The Web as an information resource in K–12 education: Strategies for supporting students in searching and processing information. *Review of Educational Research*, 75, 285–328.
- Lankshear, C. (2007, April). *The "stuff" of new literacies*. Paper presented at the Mary Lou Fulton Symposium, Arizona State University.
- Lankshear, C., & Knobel, M. (2006). *New literacies: Everyday practices and classroom learning* (2nd ed.). Maidenhead, UK: Open University Press.
- Lenhart, A., Arafeh, S., Smith, A., & Macgill, A. R. (2008). *Writing, technology, and teens*. Washington, DC: Pew Charitable Trusts. Retrieved September 29, 2008, from http://pewinternet.org/pdfs/PIP_Writing_Report_FINAL3.pdf
- Lenhart, A., & Madden, M. (2007). *Pew Internet Project data memo*. Washington, DC: Pew Charitable Trusts. Retrieved September 29, 2008, from http://www.pewinternet.org/pdfs/PIP_SNS_Data_Memo_Jan_2007.pdf
- Lenhart, A., Madden, M., & Hitlin, P. (2005). *Teens and technology*. Washington, DC: Pew Charitable Trusts. Retrieved September 29, 2008, from http://www.pewinternet.org/pdfs/PIP_Teens_Tech_July2005web.pdf
- Lenhart, A., Madden, M., Macgill, A. R., & Smith, A. (2007). *Teens and social media*. Washington, DC: Pew Charitable Trusts.
- Levin, D., Arafeh, S., Lenhart, A., & Rainie, L. (2002). *The digital disconnect: The widening gap between Internet-savvy students and their schools*. Washington, DC: Pew Internet and American Life Project.

- Retrieved October 1, 2008, from http://www.pewinternet.org/PPF/r/67/report_display.asp
- Lewis, C., & Fabos, B. (2005). Instant messaging, literacies, and social identities. *Reading Research Quarterly*, 40, 470–501. Retrieved March 28, 2008, from <http://www.reading.org/Library/Retrieve.cfm?D=10.1598/RRQ.40.4.5&F=RRQ-40-4-Lewis.pdf>
- Livingstone, S. (2008, June). Taking risky opportunities in youthful content creation: Teenagers' use of social networking sites for intimacy, privacy and self-expression. *New Media and Society*, 10, 393–411.
- Livingstone, S., Van Couvering, E., & Thumin, N. (2008). Converging traditions of research on media and information literacies. In J. Coiro, M. Knobel, C. Lankshear, & D. Leu (Eds.), *Handbook of research on new literacies* (pp. 103–132). New York: Lawrence Erlbaum.
- Macgill, A. R. (2007). *Parent and teenager Internet use*. Washington, DC: Pew Charitable Trusts. Retrieved September 29, 2008, from http://www.pewinternet.org/pdfs/PIP_Teen_Parents_data_memo_Oct2007.pdf
- Marquez-Zenkov, K., & Harmon, J. A. (2007). Seeing English in the city: Using photography to understand students' literacy relationships. *English Journal*, 96(6), 24–30.
- McManus, R. (2005, August 6). Web 2.0 is not about version numbers or betas. *Read/WriteWeb*. Retrieved October 2, 2008, from http://www.readwriteweb.com/archives/web_20_is_not_a.php
- National School Boards Association. (2007). *Creating and connecting: Research and guidelines on social and educational networking*. Retrieved September 22, 2008, from www.nsba.org/SecondaryMenu/TLN/CreatingandConnecting.aspx
- New Media Consortium. (2008). *The horizon report*. Austin, TX: Author. Retrieved September 24, 2008, from www.nmc.org/pdf/2008-Horizon-Report.pdf
- Owston, R. D. (1997). The World Wide Web: A technology to enhance teaching and learning? *Educational Researcher*, 26(2), 27–33.
- Palfrey, J., & Gasser, U. (2008). *Born digital: Understanding the first generation of digital natives*. New York: Basic Books.
- Partnership for 21st Century Skills. (2008). *21st century skills, education and competitiveness: A resource and policy guide*. Retrieved September 30, 2008, from http://www.21stcenturyskills.org/documents/21st_century_skills_education_and_competitiveness_guide.pdf
- Perkel, D. (2008). Copy and paste literacy? Literacy practices in the production of a MySpace profile. In K. Drotner, H. S. Jensen, & K. C. Schroeder (Eds.), *Informal learning and digital media: Constructions, contexts, consequences* (pp. 203–224). Newcastle, UK: Cambridge Scholars.
- Roschelle, J., & Pea, R. (1999). Trajectories from today's WWW to a powerful educational infrastructure. *Educational Researcher*, 28(5), 22–25.
- Salaway, G., Borreson, J., & Nelson, M. R. (2008). *The ECAR study of undergraduate students and information technology, 2008* (Vol. 8). Boulder, CO: EDUCAUSE.
- Salomon, G. (1993). On the nature of pedagogic computer tools. The case of the wiring partner. In S. P. LaJoie & S. J. Derry (Eds.), *Computers as cognitive tools* (pp. 179–196). Hillsdale, NJ: Lawrence Erlbaum.
- Sarroub, L. K. (2005). *All American Yemeni girls: Being Muslim in a public school*. Philadelphia: University of Pennsylvania Press.
- Scardamalia, M., & Bereiter, C. (2006). Knowledge building: Theory, pedagogy, and technology. In K. Sawyer (Ed.), *Cambridge handbook of the learning sciences* (pp. 97–118). Cambridge, UK: Cambridge University Press.
- Schrage, M. (2001). *The relationship revolution*. Retrieved October 2, 2008, from http://www.yi-tan.com/wiki/yi-tan/the_relationship_revolution
- Solomon, G., & Schrum, L. (2007). *Web 2.0: New tools, new schools*. Washington, DC: International Society for Technology in Education.
- Spires, H. A., Lee, J. K., Turner, K. A., & Johnson, J. (2008). Having our say: Middle grade student perspectives on school, technologies, and academic engagement. *Journal of Research on Technology in Education*, 40, 497–515.
- Stahl, G., Koschmann, T., & Suthers, D. (2006). Computer-supported collaborative learning: An historical perspective. In R. K. Sawyer (Ed.), *Cambridge handbook of the learning sciences* (pp. 409–426). Cambridge, UK: Cambridge University Press.
- Steinkuhler, C. (2008). Cognition and literacy in massively multiplayer online games. In J. Coiro, M. Knobel, C. Lankshear, & D. Leu (Eds.), *Handbook of research on new literacies* (pp. 611–613). New York: Lawrence Erlbaum.
- Stern, S. (2007). Producing sites, exploring identities: Youth online authorship. In D. Buckingham (Ed.), *The John D. and Catherine T. MacArthur Foundation Series on Digital Media and Learning: Youth, identity and digital media* (pp. 95–118). Cambridge, MA: MIT Press. Retrieved October 3, 2008, from <http://www.mitpressjournals.org/toc/dmal/-/6?cookieSet=1>
- Stone, B. (2007, March 3). Social networking's next phase. *The New York Times*. Retrieved September 25, 2008, from http://www.nytimes.com/2007/03/03/technology/03social.html?_r=1&scp=1&sq=social%20networkings%20next%20phase&st=Search
- Taraborelli, D. (2008). Soft peer review: Social software and distributed scientific evaluation. *Proceedings of the 8th International Conference on the Design of Cooperative Systems (COOP 08), Carry-Le-Rouet, France, May 20–23, 2008*. Retrieved October 3, 2008, from http://nitens.org/docs/spr_coop08.pdf
- Tinto, V. (1998). Colleges as communities: Taking research on student persistence seriously. *Review of Higher Education*, 21, 167–177.
- Turkle, S. (1995). *Life on the screen: Identity in the age of the Internet*. New York: Touchstone.
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Wallace, R. C. (2004). A framework for understanding teaching with the Internet. *American Educational Research Journal*, 41, 447–488.
- Wallace, R. M., Kupperman, J., Krajcik, J., & Soloway, E. (2000). Science on the Web: Students on-line in a sixth-grade classroom. *Journal of the Learning Sciences*, 9, 75–104.
- Warschauer, M. (2007). A teacher's place in the digital divide. In L. Smolin, K. Lawless, & N. C. Burbules (Eds.), *Information and communication technologies: Considerations of current practices for teachers and teacher educators. 106th Yearbook of the National Society for the Study of Education* (Part 2, pp. 157–166). Malden, MA: Blackwell.
- Wells, J., & Lewis, L. (2006). *Internet access in U.S. public schools and classrooms: 1994–2005* (NCES 2007–020). Washington, DC: U.S. Department of Education, National Center for Education Statistics. Retrieved October 3, 2008, from <http://nces.ed.gov/pubs2007/2007020.pdf>
- Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. London: Cambridge University Press.
- Windschitl, M. (1998). The WWW and classroom research: What path should we take? *Educational Researcher*, 27(1), 28–33.
- Woo, Y. Y. J. (2008). Engaging new audiences: Translating research into popular media. *Educational Researcher*, 37, 321–329.
- Yin, R. K. (1994). *Case study research: Design and methods* (2nd ed.). Thousand Oaks, CA: Sage.
- Yin, R. K. (2002). *Case study research: Design and methods* (3rd ed.). Thousand Oaks, CA: Sage.
- Zhao, C., & Kuh, G. D. (2004). Added value: Learning communities and student engagement. *Research in Higher Education*, 45, 115–138.

AUTHORS

CHRISTINE GREENHOW is a postdoctoral associate in the College of Education and Human Development at the University of Minnesota, 125 Peik Hall, 159 Pillsbury Drive, Minneapolis, MN 55455; *greenhow@umn.edu*. Her research focuses on how people learn, teach, and collaborate using emerging social digital technologies (www.cgreenhow.org). She is currently leading a study of adolescent learners' knowledge development, literacy, and community formation within and across two designed online social media spaces. She is the winner of the 2008 University of Minnesota Outstanding Postdoctoral Scholar award.

BETH ROBELIA is the executive director of Kitchen Table Learning, a research and evaluation company, 1496 Arona Street, Saint Paul, MN 55108; *brobelia@kitchentablelearning.com*. Her work on informal learning has spanned youth development, tutoring, teaching, and shipboard environmental education programs. Her work addresses how learning technologies can be used to bridge gender differences in science. She is currently investigating how construction toys and 3-D software develop students' spatial reasoning abilities.

JOAN E. HUGHES is an associate professor of instructional technology in the College of Education at the University of Texas at Austin, 244M Sanchez Building, Austin, TX 78712; *joanh@mail.utexas.edu*. Her research examines preservice and in-service teachers' development of knowledge and practice of technology integration in content areas. She is currently leading a longitudinal study with more than 7 years of data that examines the impact of 1:1 laptop computing in preservice teacher education.

Manuscript received November 2, 2008

Revision received March 11, 2009

Accepted March 24, 2009