Ubiquitous Learning

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Introduction

Mary Kalantzis and Bill Cope

The Beginnings of an Idea

This book sets out to define an emerging field, a field which for the reasons we outline in the chapters that follow, we have chosen to call ‘ubiquitous learning’. Ubiquitous learning is a new educational paradigm made possible in part by the affordances of digital media. Over the chapters that follow, we will explain what we mean by this claim, and marshal evidence in its support.

But first, who are we and how did we come to write this book? The starting point was a strategic initiative of the College of Education at the University of Illinois, the Ubiquitous Learning Institute, whose guiding ideas developed in 2006 by a task force consisting of Chip Bruce, Cynthia Carter Ching, Michael Peters, Vanna Pianfetti, Sharon Tettegah and Brendesha Tynes. This group set the agenda for the Institute in the following terms:

The world is changing rapidly from an industrial to an information and media driven economy. As the world around us becomes smaller, and communication and media become more global and more diffuse, the very nature of society and of who we are as human beings is quickly being defined by our ability to be both consumers and producers of knowledge. The nature of that knowledge, how and by whom it is created, and the spaces in which it is encountered are all rapidly evolving. Technology developments make it possible for information to be produced and disseminated by practically anyone, and learning can occur at any time and any place. This notion of “anytime/anywhere” has often been described as “ubiquitous” in the IT literature. Ubiquitous computing can mean using technology to bridge distance and time, the merging of physical and virtual, and bringing computing off the desk into social and public spaces through wearable and handheld devices. A focus on learning, and on the increasing prevalence of knowledge construction activities being conducted in online environments by experts and novices alike, however, suggests that the definition of ubiquitous be expanded to include the idea that learners can engage with knowledge about “anything,” and that this learning can be experience by “anyone.”

What we mean by learning, however, differs strongly from a common understanding. Traditionally, learning has been configured as a process whereby the learner encounters and soaks up knowledge or skill, much like a sponge, from some authoritative source. This definition is no longer sufficient to describe the convergence of knowledge conditions in the information society. Progressive theories of learning have long maintained that learners do not passively absorb, but rather actively create personally meaningful knowledge out of their experiences in the world. Now, however, learning through knowledge creation is not just about designing the understandings in one’s own head, so to speak. As we use web technology to make sense of the world around us through blogs, wikis, mash-ups, podcasts, social software, online worlds, open-source and open-access media, and a whole host of other current and emergent online practices, the constructions of our own evolving understandings become information in the public
sphere. In essence, the process of learning and the products of learning are rapidly merging into ubiquitous knowledge engagement. The implications of this profound transformation—for formal schooling, for online communities, for evolving definitions of public knowledge, and for global interconnectedness and economic development—can not be underestimated.

This is a big agenda indeed, intellectually ambitious and with potentially enormous educational implications.

From this initial statement of intent, we set a course to begin defining key concepts and exploring current practices. Although a College of Education initiative, we knew from the start that this would have to be a collaborative, cross-disciplinary endeavour. This book is the beginning of these next stage in the development of the Ubiquitous Learning Institute. It brings together some thirty different authors from across a broad variety of disciplines at the University of Illinois, Urbana-Champaign.

The ideas we present here are the product of an unique institution and an unusual cross-disciplinary partnership. At this institution, two traditions of intellectual innovation stand out that are germane to the focus of the Ubiquitous Learning Institute and the themes of this book: a technological tradition and an educational tradition. On the technological side, this was the place where John Bardeen worked, who won a Nobel Prize for inventing the transistor, then a second one for discovering superconductivity. It is a place where the first web browser, Mosaic, was created. It is also the birthplace of Eudora, Apache, PayPal and YouTube. As we write, the University is building the largest and fastest computer ever, Blue Waters. On the educational side, for half a century and more, the University of Illinois has been at the forefront of creating new approaches to pedagogy, from the ‘new’ math and reading of the sixties, to the invention of the idea of ‘special education’, to the ideas of reciprocal teaching in communities of practice in the 1980s. And, at the intersection of these two foci of intellectual interest, there was PLATO, the world’s first computer learning system. The University of Illinois is fertile ground indeed for discussion of the connections between technology and learning.

In this context, the aim of the authors of this book was to take stock of current thinking and practices using technology and learning, bringing together experts whose disciplinary perspectives were widely varied. The authors reflect a great depth of knowledge and represent remarkably diverse fields, from education (Nick Burbules, Bill Cope, David Huang, Mary Kalantzis, Faye Lesht, Michael Peters, Vanna Pianfetti, Fazal Rizvi and Sharon Tettegah), to computer science (Alan Craig, Steve Downey, Thom Dunning, Erik Jakobsson, Sam Kamin, Karrie Karahalios, Robert McGrath, James Myers and Edee Wiziecki), to library sciences (Lisa Bouillion, Chip Bruce, Caroline Haythornthwaite and Mike Twidale), to arts and design (Jack Brighton, Vernon Burton, Elizabeth Delacruz, Guy Garnett, Gail Hawisher, Maria Lovett and Joseph Squier).

The terrain these authors cover is broad indeed. To give shape to ideas which are at times expansive and challenging, the book has three parts: Part A explores key concepts of ubiquitous computing and ubiquitous learning. In the first chapter, we attempt to set the overall agenda for the book. Next, Nick Burbules examines the consequences of ubiquity: an ‘anywhere’ spatial sense, portability, interconnectedness, blurring divisions between different spheres of life, an ‘anytime’ temporal sense, and its globalised flows. Chip Bruce explores pre-digital attempts to create ubiquitous learning, from John Dewey to a library science teacher at the University of Illinois in the 1940s. Caroline
Haythornthwaite discusses the potential transformations, and the dangers, of the digital learning environment in the context of a broader opportunity to create a participatory culture. And Mike Twidale writes of the connections between ubiquitous computing and informal and semi-formal modes of learning, including what he calls ‘over the shoulder learning’.

In Part B of the book, we examine contextual factors which influence the development of ubiquitous learning. Michael Peters speaks to the broader political economy of the new media, including legal questions of intellectual property and philosophical questions of disembodiment in an environment where human interaction is machine-mediated. Jack Brighton discusses developments in digital radio as a touchstone for larger developments in the new, digital media, developments he calls ‘ubimedia’, which have the potential to empower people and create a more participatory culture. Vanna Pianfetti describes ‘Generation I’, and the kind of learning that will mesh with the skills and sensibilities of ‘digital natives’. Lisa Bouillion discusses the dangers of disconnect between tech-savvy young people, and suggests ways in which learning more connected with the ‘real world’ and using ubiquitous computing devices can create a renewed sense of relevance. Fazal Rizvi, in his chapter, moves the contextual discussion to the international stage where he explores the potentials for the African Virtual University, as well as the challenges it faces. Moving to an examination of the technological context, Myers, Dunning and McGrath examine the potentials of cyberenvironments to provide a shared foundation for new forms of collaborative research, as well as, at the same time, access for learners to the same body of foundational research data—a phenomenon, they say, will change the way science is done, and the way science education works. In the next chapter, Craig, Downey, Garnett, McGrath and Myers explore the potential of virtual worlds for ubiquitous learning. Following on from this, David Huang and Tristan Johnson investigate the nature and implications of gaming for Ubiquitous learning. Sharon Tettegah and her colleagues examine the dynamics of access grid technology in virtual classrooms. Next, Karrie Karahalios describes her research into an environment which more closely links physical embodiment with virtual presence, in which a human-scale, anthropomorphic computer figure sits at a table. Finally in this section, Faye Lesht speaks of the administrative dynamics of e-learning programs.

Part C describes some ubiquitous learning practices. Burton, Onderdonk and Appleford describe their ‘River Web’ project, developing online history resources for the East Saint Louis area. Sam Kamin presents an experiment using notebook computers in a computer science class. Eric Jakobsson explains how the ‘Biology Workbench’ is used as a tool for learning. Elizabeth Delacruz describes the place of technology in arts education. Finally, in two chapters, Maria Lovett and Joseph Squier and then Gail Hawisher and a group of her students describe writing programs that involve the use of digital video.

If we decide to make PLATO the starting point of a journey into computer-assisted learning, our travels so far have been slow—nearly half a century long. And it may well be that there is still a long way to go. It will be a long time before the vision of ubiquitous learning is realised if we find progress blocked by forces of institutional inertia and heritage senses of what education should be like. However, the extraordinarily rapid spread of computing devices into every corner of our working, home, community and
learning lives may well make ubiquitous learning a practical possibility, or even a social imperative.
PART A: Concepts

Chapter 1: Ubiquitous Learning: An Agenda for Educational Transformation

Bill Cope and Mary Kalantzis

Ubiquitous Computing

At first glance, it is the machines that make ubiquitous learning different from heritage classroom and book-oriented approaches to learning. These appearances, however, can deceive. Old learning can be done on new machines. Using new machines is not necessarily a sign that ubiquitous learning has arrived. And some features of ubiquitous learning are not new—as Chip Bruce highlights so clearly in his chapter, they have a proud place in the history of educational innovation which stretch back well before the current wave of machines.

But to focus on the machines for the moment, there is an obvious link between ubiquitous learning and ubiquitous computing. The term ‘ubiquitous computing’ describes the pervasive presence of computers in our lives. Personal computers and laptops have become an integral part of our learning, work and community lives, to the point where, if you don’t have access to a computer you can be regarded as disadvantaged, located as a ‘have not’ on the wrong side of the ‘digital divide’. Meanwhile, many other devices are becoming more computer-like (in fact, more and more of them they are computers or have computer power built in): mobile phones, televisions, global positioning systems, digital music players, personal digital assistants, video cameras, still cameras and game consoles, to name a few. These devices are everywhere. They are getting cheaper. They are becoming smaller and more portable. They are increasingly networked. This is why we find them in many places in our lives and at many times in our days. The pervasive presence of these machines is the most tangible and practical way in which computing has become ubiquitous.

Does ubiquitous computing lay the ground work for ubiquitous learning? Yes, it does. Does it require us to make a paradigm shift in our education paradigms? Certainly. However, our definition of ubiquitous learning in the first paragraph of our introduction was more conditional than this. We said ‘ubiquitous learning a new educational paradigm made possible in part by the affordances of digital media’. The qualifications in this statement are crucial. ‘Made possible’ means that there is no directly deterministic relationship between technology and social change. Digital technologies arrive and almost immediately, old pedagogical practices of didactic teaching, content delivery for student ingestion and testing for the right answers are mapped onto them and called a ‘learning management system’. Something changes when this happens, but disappointingly, it is not much. And another qualifier: ‘affordance’ means you can do some things easily now, and you are more inclined to do these things than you were before simply because they are easier. You could do collaborative and inquiry learning in a traditional classroom and heritage institutional structures, but it wasn’t easy. Computers
make it easier. So, the new things that ubiquitous computing makes easier may not in themselves be completely new—modes of communication, forms of social relationship or ways of learning. However, just because the new technology makes them easier to do, they become more obviously worth doing than they were in the past. Desirable social practices which were at times against the grain for their idealistic impracticality, become viable. The technology becomes an invitation to do things better, sometimes in ways that some people have been saying for a long time they should be done.

Here’s an apocryphal technology story about the connections between technology and social relationships. PLATO, the world’s first computer learning environment was invented here at the University of Illinois in 1960, going through extensive research and development processes resulting in a number of iterations over the next two decades. PLATO can be credited as the beginnings, not just of e-learning, but the computing world we know today. It only took the form it did in order to meet specifically educational needs. In this sense, education drove, not technology. Some remarkable inventions came out of this educational laboratory. In the 1960s, the plasma screen was invented because learners needed a visual interface, not computer punch cards, for ease of interaction in the learning context. The touch screen was also invented, so students could interact with the questions and information on the screen. In the 1970s, a pioneer messaging system was created so teachers and learners could communicate with each other. This was perhaps the world’s first online community, and the beginnings of communications technologies which soon became message boards, email, online chat and instant messaging. The first multiplayer online games were created for PLATO. The capacity to connect peripheral devices was also created, and one of the first was an early music synthesiser used in music education and research, which also had the capacity to play computer-recorded music. Now that these technologies have become cheap and accessible, we find ourselves using their descendants every day of our lives. But it is salutary to know that they were invented in a moment of educational exploration, to support the endeavour of learning. Education led. The technology followed. (And to make progress with ubiquitous learning, this needs to happen again.)

Technologies are the product of social needs. When they work for us, their social affordances sometimes prove to be more revolutionary than their technical specifications. Before we get back to the educational story, here are some of the social effects of what has, since the days of PLATO, become ubiquitous computing:

**Situated Computing:** ubiquitous computing situates information processing, communications, recording and playback devices everywhere in our lives. We make meanings through these devices (to others as well as making sense of things for ourselves). We represent ourselves through digitised media, recording more and more of our lives—deliberately, impulsively or incidentally. We do this in many media: image, text and sound, because one of the key features of the world of computing is to reduce image, sound and word to the same stuff, the stuff of zeros and ones.

**Interactive Computing:** ubiquitous computing is interactive. One move is this: person connects with machine; machine answers on the basis of its programmed functions. The machine is ‘smart’ insofar as the programmer has only supplied abstract variables. Somewhat intelligently, the machine returns to the user whatever data it has been given the chance to record, sometimes in combinations which neither the person who entered the data nor the programmer quite anticipated. Another interactive move is this: person
connects to person through the machine. Until recently, this happened through different, monomodal and relatively separate analogue media. Now the media are (literally, technically) converging around digitisation. We can connect in more ways, more easily and more cheaply. Mike Twidale in his chapter identifies this as the inherently sociable character of ubiquitous computing.

**Participatory Computing:** ubiquitous computing spawns ubiquitous media, which spawns participatory culture. Here are a few the signs of our times: the centrally designed voice of experts, the print encyclopedia, is supplant ed by the tens of thousands of unnamed authors, a ‘general public’ which has contributed to Wikipedia and which updates and extend it daily. Competing with the traditional newspaper, blogs provide information and commentary on the events of the day; anyone can set one up; any reader can talk back. And competing with broadcast television, anyone can post a video to YouTube. In his chapter, Jack Brighton calls these new, digital media, ‘ubimedia’. Unlike the old media, they are cheap, accessible and easy enough for anyone to do. This is the stuff of computer-enabled participatory culture in which the distinctions between writer and readers, and creators and audiences are rapidly becoming blurred (Jenkins 2006).

**Spatial Computing:** ubiquitous computing creates new senses of space. Where you work, where you shop, where you learn, where you are entertained and where you live—these all used to be defined spaces: built, institutionalised, impressively solid. Ubiquitous computing makes the boundaries between these spaces porous at least, but possibly even throws into question the long term relevance of the what were until recently regarded to be unshakable spatial, institutional and life boundaries.

**Temporal Computing:** ubiquitous computing also creates new senses of time. To reframe the argument Nick Burbules puts in his chapter, ubiquitous computing brings together the ‘now’ and the ‘whenever’. The start of the class, or the movie, or the working day does not need to be a specific ‘now’, when, the capacity to record easily and cheaply facilitates asynchronous communication. Now can be made sooner or later. Observing other people’s timetables is increasingly replaced by calendaring for oneself.

**Cognitive Computing:** ubiquitous computing requires new ways of mental getting around, new logics of social navigation, new uses of the computer as appendage to our thinking. We think by weaving our way through icons and hypertextual links. We search rather than follow instructions. We create our own reading paths rather than read things in the order in which the author thought would be good for us. New ways of thinking are emerging in which the mind uses the computer as a supplement to its own cognitive powers. Users work their way around the world of knowledge and imagination having mastered ‘semantic technologies’ of ubiquitous computing: search algorithms, menus, formal schemas, user-generated tags and folksonomies and ontologies. All of these allow you to work your way through the structured data of files and databases. In these activities, our thinking becomes computer-mediated.

**Intuitive Computing:** as a matter of habit, ubiquitous computing becomes a deeply intuitive part of our lifeworld experience. Adults have managed to learn their way into the world of ubiquitous computing, or at least those on the ‘have’ side of the digital divide. They become fluent second-language speakers of the languages of ubiquitous computing. They speak it very well at times, by with an accent revealing traces of a pre-digital childhood. Like ducks to water, however, today’s children have grown up as ‘digital natives’. As Vanna Pianfetti says in her chapter, they speak ubiquitous computing
as if it had always been a natural part of human affairs. So ubiquitous has this computing become that, for native and second language speakers alike, it is at hard to notice that it is even there. It’s just what we do to live today. It is as though we look through it, hardly noticing it is there.

**Causes for Caution**

For all the optimism about the social transformations that might be wrought as we explore the affordances of ubiquitous computing, we need to have a cautious eye to its ever-present dangers. We need to work hard at the digital divide in a world where inequality comes easier than equality: the ‘bandwidth disadvantaged’, the dead zones, and the people who can’t afford to buy the latest and best devices, even though they are getting cheaper (Mitchell 1995; Virilio 1997). In education, the champions of ubiquitous computing are working on this, in the form for instance of the One Laptop Per Child initiative.

We need to make sure we do more than mechanise and automate practices of the present out of conservative inertia when we have the opportunity to implement better ones or invent new ones. The machine-marked tests and the back-to-the-future learning management systems with their lock-step curriculum, spring to mind.

We also need to guard against ‘grey ecologies’ in which we are tethered to machines, or, as Michael Peters says in his chapter, caught on one side or the other of the Cartesian dualism of mind and body. We might be able to make the machines more life-like, better able to represent embodiment along the lines of the examples Karahalios and Tettegah describe in their chapters. However, just because the computing is ubiquitous, not all learning has to be machine-mediated and distanced from its natural and embodied sources. To achieve this, the machines need to be seen, not as ends in themselves, but as a documentation devices for off-screen learner activity—for instance, digital photographs taken by learners engaged in nature study, video or audio recordings of oral or gestural performance and the like. In other words, we need to guard against any reduction of the richness of person-to-person or hands-on activity. The solution for ubiquitous learning is ‘out there’ documentation (take the documentation devices with you everywhere). In other words, the learner does not have to be confined to human-machine interaction or human-machine-human mediation because the machine also serves as an ancillary documentary device for human-human, and human-activity learning.

And, as Caroline Haythornthwaite points out in her chapter, we need to watch out for networked individualism, outsourced learning-on-the-cheap that bypasses the teacher, and an anti-intellectual populism where the only thing that trumps the wisdom of the crowd is the wisdom of the sponsored link.

**Ubiquitous Learning**

We can use new technologies to do learn old things in old ways. We can set up the ubiquitous computing devices in our contemporary world to do old-fashioned didactic teaching: the teacher or publisher puts content into a learning management system; the
learner works through the content step by step; the learner does a test at the end and gets a mark which says they have passed or failed. We can use computers to recreate traditional, transmission pedagogies which anticipate a mimetic relationship to knowledge—absorb the theories, the practice formulae, the facts, the greats, the canon, the socio-moral truths that others have deemed will be good for you. There are some differences, to be sure—the image of the solar system in the old science textbook stays still but the planets move around the sun in the digital ‘learning object’—but the learner’s relationship to knowledge and the processes of pedagogy have not changed in any significant way (Kalantzis 2006; Kalantzis and Cope 2008).

Following, we suggest seven moves which are characteristic of ubiquitous learning. Each explores and exploits the potentials of ubiquitous computing. None, however, is a pedagogical thought or social agenda that is new to the era of ubiquitous computing. The only difference today is that there is now no practical reason not to make each of these moves. The affordances are there, and if we can, perhaps we should. And when we do, we may discover that a new educational paradigm begins to emerge. And as new paradigms emerge, we might find they take a leading role on technological innovation.

**Move 1: To blur the traditional institutional, spatial and temporal boundaries of education.** In the heritage educational institutions of our recent past, learners needed to be in the same place at the same time, doing the same subject and staying on the same page. The classroom was an information architecture, transmitting content, one to many: one textbook writer to how every many thousands of learners; one teacher to thirty something children or one lecturer to one hundred and something university students. The spatial and temporal simultaneity of this information and knowledge system practically made sense. Today, in the era of cheap recording and transmission of any textual, visual and audio content anywhere, such classrooms are not needed. Education can happen anywhere, anytime. Proud traditions of ‘distance education’ and ‘correspondence schools’ mean that these ideas are far from new. The only difference now is that ubiquitous computing renders anachronistic and needlessly expensive for many educational purposes, the old information architecture of the classroom, along with its characteristic forms of discourse and social relationships to knowledge. Even the problem of duty of care for children is surmountable with mobile phones and global positioning devices. Knowing the location of a child was never better than the one metre margin of error of GPS devices. And another problem with the old classroom: the idea was that this was preparation for life, enough to assume whatever one’s lot would be, and the rest could be left to experience. Today, everything is changing so rapidly that today’s education easily becomes tomorrow’s irrelevance. So, there have been moves to make ongoing training and formally accredited education ‘lifelong and lifewide’. For people in work and with families, not able to commute to an institution or able to schedule their time easily, ubiquitous computing can be a conduit for education beyond the traditional spatial and institutional boundaries. Coming together in specific times and places will, of course, remain important, but what we will choose to do when we come together may be different from what happens in classrooms today—these may be special times to focus, on face-to-face planning, collaborative work and community building. Then there’s the new pervasiveness of pedagogy in spaces of informal and semi-formal learning—help menus, ‘intuitive interfaces’, game-like staged learning, and what Mike Twidale calls in his chapter, ‘over-the-shoulder-learning’ from friends and colleagues. This kind of
learning only ever needs to be just in time and just enough. It is now integral to our lifeworlds, a survival skill in a world of constant change.

*Move 2: To shift the balance of agency.* In the traditional classroom, the teacher and blackboard were at the front of the room. The learners sat in straight rows, listened, answered questions one at a time, or quietly read their textbooks and did their work in their exercise books. Lateral student-student communication was not practicable, or even desirable when it could be construed as cheating. Underlying this arrangement was a certain kind of discipline (listen to the teacher, read authority into the textbook), and a particular relationship to knowledge (here are the facts and theories you will need to know, the literature which will elevate and the history which will inspire). This kind of education made a certain kind of sense for a certain kind of world, a world where supervisors at work shouted orders or passed down memos in the apparent productive interests of the workers, where the news media told the one main story we were meant to hear, and where we all consumed identical mass-produced goods because engineers and entrepreneurs had decided what would be good for us. Authors wrote and the masses read; television companies produced and audiences watched; political leaders led and the masses followed; bosses bossed and the workers did as they were told. We lived in a world of command and compliance. Today, the balance of agency has shifted in many realms of our lives. Employers try to get workers to form self-managing teams, join the corporate ‘culture’ and buy into the organisation’s vision and mission. Now the customer is always right and products and services need to be customised to meet their particular practical needs and aesthetic proclivities. In the new media, ubiquitous computing has brought about enormous transformations. There’s no need to listen to the top forty when you can make your own playlist on your iPod. There’s no need to take on authority the encyclopedia entry in Wikipedia when you, the reader, can talk back, or at least watch other people’s arguments about the status of knowledge. There’s no need to take the sports TV producer’s camera angles when you can chose your own on interactive television. There’s no need to watch what the broadcast media has dished up to you, when you can choose your own interest on YouTube, comment on what you’re watching and, for that matter, make and upload your own TV. There’s no need to relate vicariously to narratives when you can be a player in a video game (Gee 2003; Gee 2005).

Haythornthwaite, in her chapter, calls this the ‘new relational order’. This new order applies equally well to learning. There is no need to be a passive recipient of transmitted knowledge when learners and teachers can be collaborative co-designers of knowledge. There are many sources of knowledge, sometimes problematically at variance with each other, and we have to navigate our way around this. There are many sites and modalities of knowledge, and we need to get out there into these to be able to make sense of things for ourselves. There may be widely accepted and thus authoritative bodies of knowledge to which we have to relate, but these are always uniquely applied to specific and local circumstances—only we can do this, in our own place and at our own time. Myers and his co-authors in their chapter note that this is a phenomenon of blurring distinctions between teachers and learners, and knowledge makers and knowledge users. In this environment, teachers will be required to be more knowledgeable, not less. Their power will be in their expertise and not in their control or command routines.

*Move 3: To recognise learner differences and use them as a productive resource.* Modern societies used to value uniformity: we all read the same handful of newspapers
and watched the same television channels; we all consumed the same products; and if we were immigrant, or indigenous, or of an ethnic minority, we needed to assimilate so we could all comfortably march to the same national beat. And so it was in schools: everyone had to listen to the teacher at the same time, stay on same message on the same the page, and do the same test at the end to see whether they had learnt what the curriculum expected of them. Today there are hundreds of television channels, countless websites, infinite product variations to suit one’s own style, and if you are immigrant or indigenous or a minority, your difference is an aspect of our newfound cosmopolitanism. This is all part of the shift in the balance of agency. Give people a chance to be themselves and you will find they are different in a myriad of ways: material (class, locale), corporeal (age, race, sex and sexuality, and physical and mental characteristics) and symbolic (culture, language, gender, family, affinity and persona). In schools today, these differences are more visible and insistent than ever. And what do we do about them? Ubiquitous learning offers a number of possibilities. Not every learner has to be on the same page; they can be on different pages according to their needs. Every learner can connect the general and the authoritative with the specifics and particulars of their own life experiences and interests. Every learner can be a knowledge maker and a cultural creator, and in every moment of that making and creating they remake the world in the timbre of their own voice and in a way which connects with their experiences. Learners can also work in groups, as collaborative knowledge makers, where the strength of the group’s knowledge arises from their ability to turn to productive use the complementarities that arise from their differences. In this context, teacher will need to be engaged members of cosmopolitan learning communities and co-designers, with learners, of their learning pathways.

**Move 4: To broaden the range and mix of representational modes.** Ubiquitous computing records and transmits meanings multimodally—the oral, the written, the visual and the audio. Unlike previous recording technologies, these representational modes are reduced to the same stuff in the manufacturing process, the stuff of zeros and ones (Cope and Kalantzis 2004). Also, like never before, there is next to no cost in production and transmission of this stuff. Now, anyone can be a film-maker, a writer who can reach any audience, an electronic music maker, a radio producer. Traditional educational institutions have not managed to keep up this proliferation of media, although, as Chip Bruce says in his chapter, educators have known for a long time the value of ‘learning through the senses’. But, if educators have not picked up on the easy affordances of the new media, the students have. When they do catch up, the learning seems more relevant, and powerful, and poignant (Cope and Kalantzis 2000; Cope and Kalantzis 2007; Kress 2003). Educators will need to understand the various grammars of the multiple modes of meaning making that the digital has made possible, in the same depth as traditional alphabetic and symbolic forms.

**Move 5: To develop conceptualising capacities.** The world of ubiquitous computing is full of complex technical and social architectures that we need to be able to read in order to be a user or a player. There are the ersatz identifications in the form of file names and thumbnails, and the navigational architectures of menus and directories. There is the semantic tagging of home-made folksonomies, the formal taxonomies that define content domains, and the standards which are used to build websites, drive web feeds, define database fields and identify document content. These new media need a peculiar conceptualising sensibility, sophisticated forms of pattern recognition and schematisation.
For these reasons (and for other, much older, good educational reasons as well), ubiquitous learning requires higher-order abstraction and metacognitive strategies. This is the only way to make one’s way through the impossibilities of information quantity. Teachers then need to become masterful users of these new meaning making tools, applying the metalanguage they and their learners need alike in order to understand their affordances.

**Move 6: To connect one’s own thinking into the social mind of distributed cognition.** In the era of ubiquitous computing, you are not what you know but what you can know, the knowledge that is at hand because you have a device in hand. Even in the recent past, we had libraries on hand, or experts we could consult. Cognition has always been distributed, and the most remarkable technology of distributed cognition is language itself (Gee 1992). However, today there is an immediacy, vastness and navigability of the knowledge that is on hand and accessible to the devices that have become more directly an extension of our minds. Those who used to remember telephone numbers will notice that something happens to their minds when the numbers they need are stored on the mobile phone—the phone remembers for you. It becomes an indispensable extension of your mind. This should spell doom for the closed book exam. Educators will need to create new measures to evaluate learners’ capacities to know how to know in this new environment.

**Move 7: To build collaborative knowledge cultures.** Ubiquitous computing invites forms of social reflexivity which can create ‘communities of practice’ to support learning. Lisa Bouillion, in her chapter, calls this ‘facilitating mutuality’. In the ubiquitous learning context, teachers harness the enormous lateral energies of peer-to-peer knowledge making. This builds on the complementarity of learner differences—experience, knowledge, ways of thinking and ways of seeing. Learners also involve people who would formerly have been regarded as outsiders or even out-of-bounds in the learning process: parents and other family members, critical friends or experts. The digital workspaces of ‘social networking’ technologies are ideal places for this kind of work, at once simple and highly transparent when it comes to auditing differential contributions. Teachers will need higher order skills in building learning communities if they to ensure inclusivity and that all learners reach their potential.

Clearly, the emergence of ubiquitous computing creates new conditions for all working as education professionals and learning as students. The key is not the logic or technical specifications of the machines. Rather it is the new ways in which meaning is created, stored, delivered and accessed. This, we believe, will change the educational world in some fundamental ways—and also allow some older but good and disappointingly neglected educational ideas to work at last and work widely. The journey of ubiquitous learning is only just beginning. Along that journey, we need to develop breakthrough practices and technologies that allow us to reconceive and rebuild the content, procedures and human relationships of teaching and learning.

**Readings and References**

For a broader discussion of newly emerging educational paradigms, see our book, *New Learning*, referenced below. Henry Jenkins is a key thinker in the development of the
idea of participatory culture, exploring its implications for education. James Paul Gee and Gunther Kress have produced seminal work on the interactions between new, multimodal media and learning.


Chapter 2: Meanings of “Ubiquitous Learning”

Nicholas C. Burbules

This collection invokes the term “ubiquitous learning.” Here I would like to examine the different meanings this expression might have – different kinds of ubiquity, and in relation to that different ways in which we ought to rethink teaching and learning.

The most ordinary meaning is captured in the expression “anytime, anywhere” learning. In contemporary markets, the instantaneous and highly customizable availability of services and information is becoming a standard branding device. This ranges from being able to send and receive text messages from your cell phone, to 24/7 customer service hotlines. In education, so-called distance education, or online programs, are frequently marketed around the convenience of asynchronous and flexible class schedules, allowing people to study and complete assignments on their own timetable. This has led to a broader shift in attitudes toward such courses and programs, in which students-as-customers expect an even higher degree of customization and accommodation to their preferences, not only in terms of scheduling. As customers, they know they can take their business elsewhere.

In this essay, I want to press the idea of ubiquitous learning beyond an “anytime, anywhere” marketing slogan, and to suggest six interrelated dimensions along which its meaning can be fruitfully extended.

First, there is a spatial sense of ubiquity (the “anywhere” half of the previous slogan). In developed societies, digital technologies are always around: not only in computers and other overt computing devices, but in cars, in public kiosks, and so on. Regional wi-fi means that Internet access is only a click away, wherever you are. Constant access to information, however, also entails that others have constant access to you. Citizens and workers, in developed urban areas particularly, are situated in networks that make them available to others – whether they choose to be or not. The dystopic implications of these trends have been played out in popular films like “The Net” or “Enemy of the State,” but at the same time these trends reflect an increased public tolerance, if not even expectation, of perpetual digital presence. A colleague of mine had his computer bag stolen in a hotel in London, and within hours he held in his hands video printouts of the act taking place – while other surveillance cameras recorded the thief as he got on a public bus, rifled through the contents of the bag, and got off a few stops later. In a post-9/11 society, more and more people interpret this state of surveillance as increased security.

From a learning standpoint, spatial ubiquity means continual access to information to an extent that we have never witnessed before. The traditional distinction of formal and informal education is blurred once we recognize that physical location is no longer a constraint on where and how people learn; the processes of learning and memory themselves may be changing as people are less required to carry around in their heads all
that they need to know to get through a day effectively – if you need something, you can always look it up. I will return to this theme later.

Second, there is a portability aspect to ubiquity: handheld computing devices, even “wearable” devices, are becoming more commonplace. Portable devices can be always with you – which tends to establish and reinforce a social expectation that they should always be with you. The portability of these devices, in turn, creates new kinds of social practices – young people who no longer wear watches but use their phones to keep track of time; the many uses and conventions of text messaging that are created simply by virtue of the expectation that others will be constantly online and available. A program in Ireland, intended to help young people learn and preserve the Celtic language, gave them free phones with grammar and vocabulary software loaded on – the instructors wanted to be sure that wherever they were they could immediately access linguistic information, and it made more sense to use a device that young people would always have with them, knew how to use, and which was already seamlessly integrated into their daily social and linguistic practices. (Of course, they were constantly using the phones as phones too.) I cannot think of a better, simpler encapsulation of the principles of ubiquitous learning – in this case, learning reinforced by portability and practical integration into the activities of daily life.

Third, there is ubiquity in the sense of interconnectedness. Automobiles now come equipped with GPS systems and dashboard devices that can tell you where the next gas station or hospital is. Driving on the highway, you can find a hotel, estimate your arrival time, and book your reservation while you are still 500 miles away. “Smart homes” connect relevant devices together to share information; or you can turn off your coffee maker with your phone without returning home.

For the learner, this interconnectedness creates an “extensible intelligence,” extensible in two related senses. Technologically, one’s knowledge, memory, and processing power are enhanced by constantly available devices that can supplement and support what we are able to do in our own heads. Socially, one is perpetually in contact with others who may know things or be able to do things that we cannot do ourselves. In a real sense a person can be smarter because they have access to networked intelligence, whether it is technologically or socially distributed, or both. Educational agencies, from all age levels, have yet to come to grips with the question of what knowledge, skills, and capacities people do still need to carry around in their heads, and which ones may be less necessary than they used to be. What is necessary knowledge for the future, and what does this portend for the standard views of curriculum?

Fourth, there is ubiquity in a practical sense: how new technologies blur sharp divisions between activities or spheres of life that we have traditionally viewed as separate. Work/play, learning/entertainment, accessing/creating information, public/private are distinctions that conceptually might never have been as clear-cut as our usage suggested them to be; but for a host of social and cultural reasons they are becoming increasingly untenable as sharp distinctions today. These changes are not all technological in nature, at least not directly so: changes in popular culture, in the nature of work, in the structure and
activities of home or family life, and so on, have brought with them a host of different expectations and ways of thinking about where, how, when, and why learning takes place. It is not just that the traditional monopoly of those places we call schools, and those times we call “class periods” as the sole or even primary sources of learning, is being challenged. More substantively, the entire economy of attention, engagement, and motivation to learn needs to be rethought. Learning as a practical human activity, which is always embedded in a wider network of social and institutional contexts, needs to be seen in relation to a new set of genres and practices.

“Virtual” learning environments need to be understood not primarily in relation to technologically based “VR” experiences, but as immersive learning places in which creativity, problem-solving, communication, collaboration, experimentation, and inquiry support a fully engaged experience. These “places” are virtual not by virtue of any kind of “synthesized” reality, as that is normally understood, but in relation to dynamics of interest, involvement, imagination, and interaction that support an active engagement between a learner and a learning environment. “Ubiquity” is a different issue from “virtuality,” but they intersect at the point where immersive learning activities are fully integrated into a flow of practical doings, where there is no separation between action, reflection, and inquiry. New digital technologies, as I have tried to show, can play a crucial role here; but the larger shift I am describing is not itself dependent on any technology, but rather a shift in thinking about how structured learning opportunities can be made meaningful and relevant to learners.

Fifth, there is ubiquity in a temporal sense; the “anytime” dimension of anytime, anywhere (which is of course closely linked with spatial ubiquity and constant interconnectedness). But this temporal shift goes beyond the simple language of “24/7” availability; it reflects a changed sense of time. The use of recording devices to “time-shift” television shows, the growing prevalence of asynchronous modes of communication (for example, in online education programs), reflect a certain customization of scheduling. This yields different expectations and practices that change one’s subjective relation to time – of trying to conform the timing of events to one’s habits and preferences, and not only vice versa. These new and varied rhythms suggest a different relation, in turn, to learning opportunities – easy availability and convenience, but also a pacing and flow that are more continuous, that allow “stopping in” and “stopping out” at different moments. Every moment is potentially a learning moment, not only in the quotidian way in which that was always true – but in the sense of structured, intentional learning opportunities, more seamlessly integrated into the routine practices of home, work, and entertainment.

Another, related sense of temporal ubiquity involves the idea of “lifelong learning,” but now instantiated in a new way. Generally this term refers to principles of adult and continuing education; but in the present context it expands to mean the truly perpetual availability of learning opportunities and a changed set of expectations about continual growth and development of skills and knowledge. It is almost a cliché now to talk about frequent career changes, the need to upgrade skills and knowledge even within an ongoing career, and the shifting demands of a knowledge economy. But “lifelong
"learning" here means something more: it means that learning is not relegated to a certain age or time, a certain institutional setting, and certain set of externally oriented motivational structures. Rather, in this changed world view, to be is to learn.

Sixth, there is ubiquity in the sense of globalized, transnational networks and “flows” (in Appadurai’s sense): flows of people, information, ideas, and so on. One is never simply where one happens to be; one is also situated within a set of relations and contingencies that affect, and are affected by, these increasingly global processes. Learning for a global future, therefore, involves more than having email pen-pals in another country, going on tours or exchange programs, or learning about the customs and exports of exotic, faraway places. It is in coming to recognize the fundamental interconnections among disparate people, places, and processes, and the ways in which these influence and constrain even apparently local and individual choices.

In the picture of education I am sketching here, the nature and activities of schooling will have to change. It means that traditional boundaries need to be broken down in both directions: not only sending out new and different kinds of “homework” home with students, but bringing in to the classroom activities involving other learning tools and resources that have not typically been seen as part of schools. Schools, and teachers in schools, need to think of themselves not as the sole (and perhaps not even the primary) source of learning for many of their students – especially students above a certain age, but as brokers of a certain sort.

The school, in this model, is a kind of hub: a place that brings together, coordinates, and synthesizes disparate learning resources. The “spokes” radiating out from this hub are the connections to other learning places and activities; many of them largely if not entirely separate from the control or influence of educators. But where educators do still have influence is in helping young people evaluate and integrate the varied learning experiences they have in these other, less-planned environments. Educators also have an important role to play as equalizers between those students who have a tremendous range and number of such opportunities outside school, because of their family situation or location, and those who have far fewer opportunities. In a system of mandatory education, the school is still the one common learning place students share; and that gives it a unique and important responsibility, compared with other learning places. But starting from this premise yields a different basis for planning about what needs to take place there, one that links school aims and activities much more fundamentally to learning that is taking place elsewhere.

Further Reading


Chapter 3: Ubiquitous Learning, Ubiquitous Computing, and Lived Experience

Bertram C. Bruce

Ubiquitous learning is more than just the latest educational idea or method. At its core the term conveys a vision of learning which is connected across all the stages on which we play out our lives. Learning occurs not just in classrooms, but in the home, the workplace, the playground, the library, museum, and nature center, and in our daily interactions with others. Moreover, learning becomes part of doing; we don't learn in order to live more fully, but rather learn as we live to the fullest. Learning is through active engagement, and significantly, is no longer identified with reading a text or listening to lectures, but rather occurs through all the senses - sight, hearing, touch, feel, and taste.

It is understandable to see ubiquitous computing necessary for this kind of ubiquitous learning and sufficient to make it possible. Education would certainly be easier to promote if we could simply identify some new technologies that would make ubiquitous learning occur. But in the sense presented above, the new technologies are neither necessary nor sufficient for this to happen. This chapter develops these ideas more, arguing that it is our vision for ubiquitous learning that matters most, not simply the technical affordances. We need to define ubiquitous learning in an historically legitimate way, one which recognizes the possibilities afforded by the new technologies without reducing the argument to a technocentric position.

Why Do We Need Ubiquitous Learning?

Speaking about the saber-tooth curriculum, Harold Benjamin (1939) quotes "wise old men" who say "we don't teach tiger-scaring to scare tigers; we teach it for the purpose of giving that noble courage which carries over into all the affairs of life." These wise old men are defending a curriculum disconnected from lived experience, which is the antithesis of ubiquitous learning. Benjamin, who imagines the saber-tooth curriculum in his satire, thinks the curriculum should instead respond dynamically to a changing world and connect to the activities of that world. He would have celebrated ubiquitous learning as the alternative for a modern world.

Benjamin was undoubtedly influenced by John Dewey, and others of the progressive education era. In The School and Society, Dewey (1915) articulates a similar vision. He starts by identifying a problem in the separation of academic knowledge from daily life. He might have responded to this separation by relegating schooling to one or the other of these pursuits. In the former case, schooling would be focused on classroom-based study through books and lectures; in the latter, it would be apprenticeship in contemporary work. But Dewey rejects this dichotomy. Instead he envisions connecting the school to life. Activities in the school would occur in spaces lying between the academic realm represented by disciplines, libraries, and museums on the one hand, and the everyday realm of work and family life. Figure 1 shows part of what this school
might be, with a library at the center and activity rooms at each corner linking to activities in life beyond the school. In fact, the activities would serve to integrate these realms, thus making everyday life richer and more reflective, and making academic work more relevant to lived experience. Within the full development of this idea lies Dewey's belief that education is key to social reform.

Figure 1. Part of Dewey's vision of schooling connected to life, adapted from The School and Society, Chart III.

Dewey's vision rests upon the idea of three sets of technologies: those of the workplace, farm, and home; those of the academy, such as libraries; and, sitting between these, the technologies of learning, which exist in the kitchen or shop of the school. Because the technologies of the first two spheres of activity had grown far apart, a rather elaborate apparatus is needed to reconnect them. Dewey felt that in his day the distance between these technologies made them difficult to relate to one another, and as a result, neither could respond effectively to the dramatic social and technological changes.
underway in the world at large. His school would give students the opportunity to combine theory and action in a way that would enrich both, make learning more exciting and meaningful, and thereby establish a model for progress in the larger society.

The school that became the actual Laboratory School is important for what it showed about the possibilities for learning, as well as for its failures (Tanner, 1997). Dewey's vision and the photos of engaged learners from the early days of the Laboratory School are inspiring. Yet there is something discomfiting about the elaborate apparatus that Dewey invoked. In Dewey's time, the activities of the factory, the school, and the university were dissimilar; he had to work forcefully to mesh them together.

In contrast today, we find that ubiquitous computing has become part of home, community, work, and the academy. We connect with a friend, shop for a toaster, build a business, study medieval history, write a memoir, or arrange travel online, often using the same tools regardless of the sphere of activity. Dewey's dream of schooling that links the mind and the body, theory and action, or disciplines and ordinary experience seems more realizable than ever. It seems clear that ubiquitous computing is both necessary for this and sufficient to make it happen. But is it either necessary or sufficient?

Is Ubiquitous Computing Necessary for Ubiquitous Learning?

For Dewey, the consequence of radical change in social life was that the school required a similar transformation. This led him to imagine new technologies for learning, as shown in Figure 1. Are there more seamless alternatives to his way of addressing this problem? Do we need to leap all the way to nanotechnology or implanted computers in order to enact more dynamic and robust learning?

Nearly a half century after the first edition of The School and Society (1900) and a half century before the Deep Blue (a computer) defeated Garry Kasparov in two chess matches, Gwladys Spencer was an instructor at the University of Illinois Library School. This was during what most people would consider the prehistory of the information age (see more in Bruce, 2003). I found a list of "Audio-Visual Materials and Equipment to be Utilized by Libraries in the Educational Program" from a course she taught in 1946.
Hers is a remarkable list (see below), including expected items such as "blackboards and bulletin boards," but many unexpected ones as well. She included television (in 1946!), showing that she had foresight about its eventual prominence as a communications medium. She also included tools for investigation, such as microscopes, and "models, objects, specimens." She clearly saw that audiovisual materials were more than simply devices for transmitting information. But more striking still is the inclusion of "pantomimes, playlets, pageants, puppet shows, shadow plays" and "trips, journeys, tours, visits." The presence of these says that she saw all of the elements of her list as opportunities for enriching experiences, rather than simply as media for transmitting information.

Taking our cue from Dewey's diagram, we might represent some of Gwladys Spencer's vision as in Figure 2. Here, the activity spaces include dramatics, investigations, trips, and working with objects, just some of the activities implied by her list. Just as Dewey proposes, she emphasizes opportunities for learners to act in and on
the world. Even the presentational media on her list seem to be conceived in a manner quite different from today's emphasis on using PowerPoint to convey course content. The posters, charts, and pictures are there because they are important media in the world, and much can be learned by investigating them, not because they are a convenient way for instructors to organize their notes in easily digestible chunks.

Types of Audio-Visual Materials and Equipment to be Utilized by Libraries in the Educational Program

1. Blackboards and bulletin boards
2. Posters, cartoons, clippings
3. Dramatics: pantomimes, playlets, pageants, puppet shows, shadow plays
4. Trips, journeys, tours, visits
5. Models, objects, specimens
6. Charts: organization or flow, table, tree or stream
7. Graphs: area, bar, diagram, line, pictorial statistics
8. Maps: flat, relief, projected, electric, globe (celestial or terrestrial)
9. Microscopes
10. Microprojectors, reading machines; microfilms, microphotographs, microprint
11. Stereoscopes; hand, binocular, televiewers; stereographs, disc for televiewers
12. Flat pictures; photographs, prints, postcards, positive transparencies
13. Still pictures projectors and projected-opaque, filmslides, slides (glass, cellophane, ceramic, etc.)
14. Sound filmslides projectors; sound filmslides
15. Motion pictures projectors and projected: silent films, sound films
16. Sound recorders: transcriptions
17. Phonographs; disc, wire; recordings
18. Talking books
19. Radios, loudspeakers, public address systems, intercommunicating systems
20. Television

Aside from the details of which tools she had available, the list shows that Spencer had a broad view of how libraries could support learning and, more important, a vision of what learning could be. Today, we are excited about multimedia in education. But what we often mean is simply that a computer display can show students moving pictures with sound. Interactivity is an important additional component. But our vision of what that multimedia really means for learning needs to go beyond the technical features of the display to consider what students can do and how they can extract meaning from their own experiences. Spencer saw that there were many tools and media that could
enlarge learning. She drew from traditional as well as emerging technologies to lay out a spectrum of possibilities for teaching and learning. Her list suggests an openness to diverse ways of learning and, moreover, a view of learners as active constructors of meaning. In so doing, she shows that ubiquitous learning depends more upon our pedagogy than on our technology.

Is Ubiquitous Computing Sufficient for Ubiquitous Learning?

In recent work, the vision of ubiquitous learning has been linked closely to an array of new information and communication technologies. No longer confined within large metal boxes or even tied to the wall with wires, these technologies have become portable, wearable, and distributed. They are embedded in dishwashers, cameras, and medical monitors, and make possible smart cars, roads, houses, and offices. As ubiquitous computing has become more and more part of our everyday reality, ideas related to ubiquitous learning have likewise become more prevalent.

If you walk across a college campus today you will see students plugged into their ipods and cell phones, with laptops in the backpacks and maybe PDAs as well. They appear oblivious to the natural world around them, to the point of endangering their lives crossing the street. Always multitasking, they connect with friends through social network sites, live through online games and immersive environments, capture events with digital cameras, and write about their most intimate experiences and thoughts in their blogs. Watching them learn through Google and YouTube, finding their way with GPS, and maintaining social relations through constant electronic connections, it is difficult to escape the thought that new forms of living and learning have already arrived.

Even if we don't embrace all that is new here, it seems imperative to engage with it to some extent if we are to understand literacy in the information age (Bruce, 2003, Coiro, Knobel, Lankshear, & Leu, in press). It also appears that a kind of ubiquitous learning has arrived without any intention or forethought; the technologies alone have made it happen. There is no doubt that new forms of learning are already happening through social networking, online videos sites, and environmental sensors.

Are these technologies sufficient, or do we still need the vision of a Gwladys Spencer? A recent study addresses this question in the context of a university course, Plants, Pathogens, People, which uses a rich array of both new and old information and communication technologies (D'Arcy, Eastburn, & Bruce, in preparation). The authors began with an attempt to identify which of these technologies were most effective at promoting engaged and connected learning. They were especially interested in fostering connections between the university classroom and life outside, as well as learning that integrates laboratory work, scientific theories, history, and public policy. They introduced new media, such as podcasts, which seemed to be salient in the students' lives. In short, they sought to make the college classroom more conducive to ubiquitous learning.
The major result of the study was that across diverse learning styles, majors, and genders, many of these media were deemed to be useful for all learners. Moreover, the usefulness of a particular medium depended much more on how it fit with others, how it related to course content, how the instructors used it, and other contextual factors than it did to any intrinsic media properties. Overall, the findings suggest there is no ideal instructional medium, nor even specific media being best for particular students. It is true that there are differences according to student learning style or instructor teaching style, but the overriding message is the need to consider the entire learning ecology (Cross, 2007; Bruce, 2008, in press; Bruce & Hogan, 1998; Nardi & O’Day, 1999).

A similar message comes through the work of Barbara Ganley (EdTechTalk, 2006; Ganley, 2007). Building on her students' experiences with new media and social software, she works with them to create a blog community, which connects within the classroom and reaches beyond it to people and experiences around the world. It is
noteworthy that Ganley devotes two weeks at the beginning of each class to develop a shared vision of learning, community, and technologies. As with the study described above, the technologies alone are far from sufficient. Instead, we need to think about the histories of learners, how technologies serve in relation to changing learning needs, and how diverse resources can be used in a concerted way. Technologies need to be re-created in line with a vision of ubiquitous learning if they are to achieve that goal (Bruce & Rubin, 1993).

Conclusion

As with many versions of hyphenated learning—active learning, engaged learning, situated learning—it is tempting to strip away the modifier, ubiquitous. Learning is an aspect of living not of place. We have always been able to learn in diverse settings other than the formal classroom, and often in a more pleasant, memorable, and useful way. Nevertheless, ubiquitous learning serves to remind us of the need to continually re-examine how learning occurs and to attend to the affordances of new technologies.

The examples here reinforce the value of ubiquitous learning and suggest ways that various technologies may support it. They also remind us to situate technologies in a larger context, and to see them organically (Haythornthwaite, et al., submitted). Arguing that it is time to move from the teaching machine metaphor to Dewey's idea of tools, Wibur (1995) writes,

An expanded concept of instructional design that includes the purpose of education, the need to teach the person as well as the content, and the importance of the social context of learning is required before we can implement computer-based collaborative learning for the children in our schools.

The array of technologies that we might group under ubiquitous computing can help implement an expanded concept of not just instructional design, but of learning in all its contexts and forms. Yet we must maintain a critical stance. Speaking in 1984, but with an enlarged relevance today, Ursula Franklin says (republished in Franklin, 2006, p. 214),

In the powerful trends of the new industrial revolution, people have to adapt to the work, habits, and values of the machines. People are generally regarded as the sources of problems, while devices are considered as means to solutions...The elimination of some of these social settings [a consequence of redesigning activities of production] also eliminates the opportunities of developing those human skills that are fundamentally different from the skills of machines: abilities such as listening, interpreting, instructing, and working out to mutually acceptable accommodations. But it is the skills, more than anything else, that the global village needs.

Our vision of ubiquitous learning must maintain at its core a concept of those fundamental human skills. We feel that ubiquitous computing technologies help us solve problems, create/access knowledge, and build community. We feel that they do it in a way that links work, family and friends, learning, and life. But the very seamlessness of
these technologies is seductive. Ellul's concept of the technological milieu is still a propos: "Every technique makes a fundamental appeal to the unconscious." (1964 p. 403). We need to ensure that employing new technologies enhances rather than diminishes our capacity to develop as whole human beings.

**Readings and References**


College Press.

Learning, in its many forms, from the classroom to independent study, is being transformed by new practices emerging around Internet use. Conversation, participation and community have become watchwords for the processes of learning promised by the Internet and accomplished via technologies such as bulletin boards, wikis, blogs, social software and shared internet-based repositories, devices such as laptops, PDAs, cell phones and digital cameras, and infrastructures of internet connection, telephone, wireless and broadband. Early discussion of the Internet extolled its transformative potential for democracy, perhaps best demonstrated by the US presidential nomination campaign around Howard Dean in 2000, and contemporary political blogging. This kind of inclusive, participatory action has now spread to many other aspects of daily life, demonstrated in: listservs and discussion groups; recommender systems (Resnick & Varian, 1997); cooperative classification systems (folksonomies; Mathes, 2004); collaboratively built, wiki-based encyclopedias (Wikipedia), dictionaries (Wiktionary), and local resources; and citizen journalism in blogs and photoblogs. These emergent, participatory trends are often brought together under research and ideas about social software, collective intelligence, distributed cognition, and collaboration. They are brought together more generally in the commercial sector under the label Web 2.0 (O’Reilly), in the economic sphere under discussion of peer production (Benkler, 2002, 2004, 2005), and most recently in education under the idea of participatory culture (Jenkins, 2006). In education – in learning and teaching – they harbinge a coming radical transformation in who learns from whom, where, under what circumstances, and for what and whose purpose. In short, they indicate a transformation to ubiquitous learning – a continuous anytime, anywhere, anyone contribution and retrieval of learning materials and advice on and through the Internet and its technologies, communities, niches and social spaces.

These trends are exercising a significant impact on learning practices. They bring with them changes in where we find information, who we learn from, how learning progresses, and how we contribute to our learning and the learning of others. These transformations are captured in ideas such as computer-supported collaborative learning (CSCL; Koschmann, 1996), community-embedded learners (Kazmer, 2007), braided learning (Preston, in press; C. Jenkins, 2004), online learning communities (Jorbring & Saljo, in press), and where the term ‘e-learning’ signifies a transformation in learning rather than a transition from off- to on-line (Andrews & Haythornthwaite, 2007).

While these transformations are thrilling, and often hyped with breathless abandon, no action is without its reaction. Transformations that do not fit so easily into utopian visions are those that act at the periphery of the general movement to ubiquitous learning. Trends that accompany distributed practices include outsourcing, offshoring, disintermediation, networked individualism (Wellman, 2002), and the downstreaming of processes and responsibilities to individuals. An autonomous learner is responsible for, and in many
cases alone in creating their own learning context and content as they search the internet for materials to support their needs. Although writers such as Jenkins extol the virtues of students learning to engage in “collective intelligence” in a “community that knows everything and individuals who know how to tap the community to acquire knowledge on a just-in-time basis” (p. 42), such an ideal overstates the knowledge that may be present in such communities, the imbalance in who does the work and who benefits, and the actualities of altruistic contribution necessary to maintain critical mass and to sustain working knowledge communities. It understates the work needed to sustain useful and usable resources, and ignores the efforts and techniques embodied in certain roles and practices, now swept away as every individual is his or her own journalist, librarian, writer, and publisher.

Of concern in this hype is how much attention addresses the unlimited possibilities for retrieving from online sources and how little addresses understanding the limits to such sources, and the now user responsibility for critical evaluation of retrieved information, online authors, online sites and search engine algorithms. While passing reference is made to the use of traditional information gatekeepers – professional editors and librarians – little is mentioned of the work that devolves to the user when such gatekeepers are absent. Instead, educational rhetoric focuses on critical media literacy for individuals. Vetting sources, sorting fact from fiction, and distinguishing commentary from original data falls to individuals, or, as increasingly seems the case, to hidden algorithms owned by search engine companies. Little is said of the limits to online information. While academics lament students’ reluctance to examine print resources, how many among us turn around to pull a dictionary from the shelf when our hands are on the keyboard? The Pew Internet project (Horrigan, 2006) reports that convenience heavily outweighs accuracy as a reason for using the internet for obtaining information. Specifically for science information, they report that 71% of the adult population surveyed turn to the Internet because of its convenience, and only 13% because they feel it is more accurate. The other 12% feel the information they want is only available online. The report confirms that the work of verifying resources has fallen to the user; 80% of these adults do some sort of “fact-checking” of this science information. They check at least another online source (62%), an offline source (54%), or the original report (54%). It appears that an online source is not a trusted source.

Another issue exists in our routes to information. Figures indicate that one search engine – Google – dominates as our retrieval mechanism for information on the web. In July 2007, Google was used for 50-65% of all searches in the US, followed by Yahoo (20-27%), MSN (8-10%), and Ask (3-5%) (sources are comSource, and Hitwise, as cited on the ClickZ site; Burn, 2007). In February 2007, Google dominated globally as the search engine most used (77%; source is Hitwise as cited on the ClickZ site; Jarboe, 2007). While Nielsen ratings also notes that users are expanding beyond a single search engine, with about two-thirds using at least two search engines (Jarboe, 2007), how many of us choose to search for a particular item using more than one search engine? What are we missing by searching using only one or two algorithms for retrieval?
Google’s dominance implies that our information practices are becoming fixed not just around what information is or is not online, but also around the common source(s) we use to locate such resources. This is also brought home in the statistics about the use of Wikipedia. A Pew report for March 2007 shows that of the Internet traffic classified as relating to an education and reference cluster of websites, Wikipedia nets 24% of the traffic, followed far behind by 3-5% for Yahoo! Answers, Dictionary.com, and Answers.com, and 1-2% for SparkNotes, Google Scholar, Google Book Search, Find Articles and U.S. National Library of Medicine (Source: Hitwise data for week ending March 17, 2007 as quoted in Rainie et al, 2007).

Verifying facts, using more than one search engine, and going beyond one source are all aspects of a new information literacy. Critical media literacy now entails more than just whether the information is credible or not, but also whether the search has been inclusive and diverse enough to provide more than one resource on a topic, or one entry to the information on a topic.

Finally, in the rush to grapple with retrieval, where is the effort to understand the dynamics and importance of contribution? What is the meaning of participation in an age of wiki wars, information saboteurs, and information vandals? (Kleeman, 2007). Where do we teach, encourage, and model participatory practices in a way that promotes useful and usable online information? New social skills, or perhaps older ones now transformed online, become essential for a workable online future. Individual retrieval becomes collaborative participation, as Jenkins (2006, p. 20) states: “the new media literacies should be seen as social skills, as ways of interacting within a larger community, and not simply an individualized skill to be used for personal expression.”

However, in this ideal of training all to participate online in an equal, democratic manner, little attention has been given to likely changes in distributions. Discussions that extol the open web as a limitless source of all information ignore the potential and reality of knowledge enclaves. These may be seen positively as think-tank retreats, with entry by invitation only, permitting the selected elite to work unharassed by novices and random visitors. Or they may be seen negatively as gated communities, segregated from outside influence or input, carrying on in private, creating internally-constructed views of reality. As many of us joined listservs and academic discussions at their inception, and have accumulated a 10-20 year growth in our common community, what are our limits to tolerance of newbie questions, yet more requests for literature on a well-worn subject, and the discoveries and social practices of the next generation? What will be the profile of these sites in a few years – their demographic, interaction norms, and content level?

Such trends and concerns, both pro and con need to be given considerable attention by educators and professionals, since one potential outcome is an outsourcing and bypassing of professional roles, resulting in further burden on individuals to create and enact their own learning. However, an alternative is the rejuggling of roles to address the needs of a learning in a participatory culture. This remainder of this paper explores the participatory trends affecting internet use and learning, with a view to understanding the
transformations that are happening and poised to happen in learning roles, locations and practices.

**Participation**

Participation connotes contribution to a community, and, in particular, contribution that furthers the goals and agenda of the community. It signals engagement and identity with the whole, demonstrated through attention and, in most cases, conformance to community norms and practices. Non-conformist contributions have their place, but entail participation only where eventually accepted as furthering the group agenda rather than that of the individual. ‘Trolls’ in online forums, and ‘griefers’ in online games, do not participate, but instead exercise personal dominance by commanding attention to themselves and away from the group. By contrast, participants are notable for their attention to others and to ongoing community interaction, and a reflexivity about their visibility whether in text, through video, or by physical presence. As noted by Benkler (2005), contributors exhibit a ‘self-conscious use of open discourse’ (p.15), for example in Wikipedia, a “self-conscious social-norms-based dedication to objective writing” (p. 14).

To participate requires knowing how to provide a contribution, which is predicated on knowledge about the reach, content, and extent of community membership, behaviors and concerns. It shares commonalities with ideas of collaboration (e.g., see Swan, 2006; Haythornthwaite, 2006a, 2006b; Haythornthwaite, Lunsford, Bowker & Bruce, 2006), and in many senses a ‘collaborative culture’ may be synonymous with a ‘participatory culture.’ If there is a distinction to be made, it is that the former tends to be used in referring to smaller working groups, particularly in the sciences, and in interdisciplinary collaborations, and in the more general conception of Communities of Practice (Lave & Wenger, 1991; Wenger, 1998). Collaborative culture tends to refer to groups that do the (often hard) work of learning to work with each other, toward common goals and outcomes. By contrast, participatory culture signals a trend to societal practice, used more widely to encompass youth as well as adult practice, arts and humanities as well as sciences, and low barriers to entry (e.g., the simplicity of wiki syntax, and participation without membership). Indeed, low technological barriers to participation appear as a key defining feature of participatory culture, as Jenkins (2006, p. 3) describes:

A participatory culture is a culture with relatively low barriers to artistic expression and civic engagement, strong support for creating and sharing one’s creations, and some type of informal mentorship whereby what is known by the most experienced is passed along to novices. A participatory culture is also one in which members believe their contributions matter, and feel some degree of social connection with one another (at the least they care what other people think about what they have created).

Low barriers do not, however, mean no barriers. Because participation requires awareness of others – or at least that there is an audience of some known or unknown size and range – apprehensions about visibility and the persistence of postings remain as
social barriers (Bregman & Haythornthwaite, 2003; Sproull & Kiesler, 1986, 1991). The continuous appearance of new technologies, even as these become simpler to use, represents another barrier as norms and practices are constantly learned and re-learned.

Moreover, in the rush to get people involved in posting, the invisible work related to posting, and the role and place of invisible participants in participatory cultures, remains – well – invisible. The work of learning to post – often learned as part of peripheral participation – is forgotten as irrelevant to a participatory culture. The hidden work of gaining access to the technology, learning the ins and outs of the applications, and learning the social norms of participation are overlooked in favor of attention to postings. Yet, watching at the periphery as a way of apprenticing with the expert is indeed legitimate participation, as so identified by Lave and Wenger (1991). As more and more effort goes into considering how to encourage participation, an equal effort must go into considering the work of becoming a poser, and the place of lurkers, observers, apprentices, and non-users in the practice of participatory culture (see also the work of Susan Leigh Star on invisible work and infrastructure: Star, 1999; Star & Strauss, 1999; Star & Bowker, 2002; for a report on non-users and the internet, see the Pew study by Lenhart et al, 2003).

Another aspect of participatory culture that requires attention is its directionality: both giving, posting, and conversing, and retrieving, reading, and absorbing. Onto this directionality we impose reflexivity. As described above, participation requires knowledge of the culture into which one posts, and in the action of posting, it also involves reflection on the post in the context of its posting, including its form and purpose (genre), audience, and conformity or defiance of norms (see also work by Carole Miller, Mikhail Bakhtin and John Swales; e.g., Miller, 1984, 1994; Bakhtin, 1986; Swales, 1990). An equal reflection needs to be given to retrieval of such posts. As Jenkins (2006) and many others contend, education about critical literacy and critical media skills come to the fore in such a free-for-all posting and participatory culture. Skills need to be inculcated to recognize wheat from chaff, skills that have, until now, largely been embodied in publisher selection criteria, library collection development policies, and educator curriculum and course development practices.

Reflexive participatory practice also implies mobility, as we enter into and out of “affinity spaces”, enjoying fluid and dynamic membership in different communities (Jenkins, 2006, p. 9). While Jenkins describes these affinity spaces as “highly generative environments from which new aesthetic experiments and innovations emerge,” this may again be a somewhat overstated utopian view of online engagement, and one that ignores the very benefits of light-weight participation, picking and choosing not only what space one will engage in, but also the extent of that engagement. Indeed one of the very purposes of such spaces is to learn and enjoy the status quo; and, at most, to participate in evolution rather than revolution. Imitation may be the highest form of flattery, but it is also an important part of language and community building. Copying others’ behaviors, language, visualizations, narrative style, and genres has long been recognized as signaling membership in a community (e.g., Miller, 1984, 1994). It is practice to be embraced, and taught.
In embracing participation, both light- and heavy-weight engagement need to be considered, in parallel to ideas of weak- and strong-tie, social network formation (Haythornthwaite, 2007). Each kind of participation has its own merits. Mobility affords the opportunity to engage in information tourism, visiting sites, treading lightly in the online venue, ‘taking only pictures and leaving only footprints.’ Mobility also affords finding the site where you want to settle, put down roots, and engage with community values and directions. Each has its own information, social and communal merits – weak ties for wider exposure to opinions and ideas; strong ties for personal commitment and motivated contribution. They exist in parallel and the spectrum of engagement is a constituent part of what is participation. Thus, each space depends on some heavy-weight users and the many more light-weight users who connect this space to other venues. As in other areas of technology development, emphasis on the strong-tie only connection has largely ignored light-weight participation, and emphasis on in-depth communal relations has ignored the benefits to diversity of multi-site, multi-task engagement (for more on strong and weak ties in online communities, see Haythornthwaite, 2002).

The New Relational Order

New technologies forge new relations, and new roles for participants. This is highly evident in the way online spaces are transforming educational and authoritative practice. The following lists, in brief, some emergent trends evident in current practice that affect and are affected by the development of participatory culture, with particular attention to learning contexts.

Change in relationship with leaders

• What is expertise in the age of participatory learning, and whose definition is it anyway?

Perhaps the greatest fear among those who have spent years achieving doctorates and then tenure is that they will be obsolete or unimportant in the classroom. Similarly, information professionals, who have done the work of collecting, classifying and establishing retrieval mechanisms for information feel by-passed as students and readers move to unvetted online sources and search engines. What value does expertise have if learners are only learning from each other, if everyone can get the information on the web? The latter concern is another overstated one: textbooks have been available for less than the cost of a PC for a long time, so why the worry about online resources? A greater worry should be that learners will think the experts unnecessary, turning to online forums, blogs and communally-defined encyclopedia for what they need. For example, why grapple with library collections when user-generated tagging in social bookmarking systems such as CiteULike, Connotea, or del.icio.us produces folk taxonomies that may better reflect contemporary organization of information (folksonomies; Mathes, 2004) – and which are at our fingertips. So, too, why grapple with university degrees and diplomas if learning can be achieved through online communities. To some extent the major job of the 21st century may be selling a university education in the age of digital
competition – and not just competition from online universities, but also from user-generated learning communities. True, the certification of a degree from a particular university may still matter, but we have to ask ‘to whom will it matter?’ (see also, Pittinsky, 2003; Levine, 2003).

Change in relationships with concurrent learners

• In an age of participatory culture, and participatory learning, what are the roles of learners and teachers? What are the practices required of each?

A result of the last 10+ years of online learning has been the evolution and re-negotiation of what is required of teachers and learners. For example, where bulletin board contributions replace classroom participation as they do in online learning courses, equal and sustained student participation becomes vital to a successful class. The role of students changes; they take on being more responsive to each others’ questions and needs, thus changing the role of the teacher. The teacher as ‘sage on the stage’ is being replaced by the facilitating ‘guide on the side’. But also the student ‘empty vessel’ is being replaced by a ‘learner-leader’ (Montague, 2006), who leads and contributes to their own learning and learning by others in the community.

Participatory learning entails instructors ceding leadership and control of learning, giving it over to participants, and encouraging a new form of co-learning pedagogy. Learning practices change from models of transfer of knowledge from one to many (e.g., instructor to students), to exchange of knowledge among many (students to students); and from transfer from expert(s) to novice(s) to collaborative, peer-to-peer learning and discovery. In this new paradigm, novices help each other make sense of the information they are receiving. They create explanations of phenomena that fit their local setting, re-supplying context that is often lost in decontextualized learning, and feeding that information back into the learning environment (Kazmer, 2005; Montague, 2006). Where appropriate, participants come to shared definition of meanings through collaborative, conversational interaction. Such emergent learning practices reinforce ideas posited by collaborative learning theories (for more on new models, see Haythornthwaite et al, under review, and the models described there, including Kazmer’s (2005; 2007) ‘embedded learners’, Preston’s (2002; in press) ‘braided learning’, and Montague’s (2006) ‘learner-leader’ model).

Changes also occur with the entry of computerized personal space into the public space. While some view laptops in the classroom as threats to engagement because students can continue to participate in out-of-room communities (e.g., via social software, email), others adopt strategies for co-opting and integrating the use of laptops into daily practice become more widespread, e.g., disseminating lecture materials to laptops for enhanced note-taking, or involving students in class in searching or other online exercises.

Of course, one of the questions arising from all this participation from newbies and non-experts is whether it is creating a nation of citizens or a “nation of ankle-biters”?
“I celebrate the liberating tools that let people post their thoughts unfiltered. But as with many other utopian predictions about how the open nature of the Net will create arenas that transcend foibles of the physical world, our faults have followed us to cyberspace. We were promised a society of philosophers. But the Blogosphere is looking more and more like a nation of ankle-biters.” (Levy, 2004).

Levy’s frustration with bloggers is easily mirrored in experiences of listserv and online class participation. Murphy & Collins (1997) noted early on the need to manage online discussion in classes so students engaged appropriately. However, this early attention focused on inhibiting inappropriate and off-topic behavior. Now, the focus is on how to increase participation in online classes, trying to compensate for the reduced cues of the online environment on the way to creating online learning communities (Barab, Kling & Gray, 2004; Jorbring & Saljo, in press; Renninger & Shumar, 2002; Swan, 2006).

But generalized participation has its limits. In forums open to anyone, current learners may tolerate questions about the basics, but when novices mix in forums for experts, such questions are likely to be answered by being told to read the FAQ, search the archive, or search the web. The mix of levels of expertise in a forum, listserv or participatory space, requires tolerance of continuous reinvention of the wheel. Such multi-level interaction suggests a limit to the utility of a single forum, leading to factions and splinter groups (for a negative connotation), or to specialty groups (for a positive connotation). Prime movers may themselves move out as their spaces become inhabited by newcomers, or by intolerably disruptive behaviors. Unbridled participation without attention to group and space norms will have fallout. We can expect to see more gated communities and moderated lists arising as the tragedy of the commons strikes repeatedly in cyberspace.

Change in relationship with previous learners

- What will become of the persistent record left by so much participation? Will its historical record be used? How will it be mined for learning?

Online conversations and postings in listservs, bulletin boards, web pages, blogs, wikis, leave an accessible record that can be reviewed and revisited. Such persistent records can leave earlier learners still present in an online conversation long after they have left the community. Although written records have persisted in the past, the easy search and retrieval of online records makes their impact all the greater. Searching now often turns up essays written for classes, syllabi of courses, discussions on listservs. Although not generally made public, whole course conduct is saved in iterations of online classes. What use will be made of these various persistent records?

As noted above, in open forums many levels of expertise may mingle. Already the FAQs represent some conversation with earlier participants, as does examining the archive of a list for previous discussion. Multi-level interaction can be expected in some learning communities, with different trajectories and continuities of participation and narrative co-existing.
Persistence in the data record also allows for near-term use. How will transaction records be used to enhance, monitor and/or assess online interaction in learning settings? Hyperlink analyses already examine interconnections among ideas (e.g., in the areas of webometrics, Thelwall & Vaughn, 2004; and hyperlink network analysis, Park, 2003). Efforts in data mining are just now beginning to enter the learning area; although not yet used extensively, it can easily be imagined that it will not be long before at least some basic statistics from such applications will be integrated with learning management systems (Minai-Bidgoli, Kortemeyer, Punch, 2004; Haythornthwaite & Gruzd, 2007).

Change in relationship with documents

- What’s in a name? What is the worth of a publisher’s or journal name in the age of wikipedia?

As more and more information goes online, as noted above, the effort to establish what is correct, truthful, balanced, and worth paying attention to is increasingly falling to users. Although this may seem to have been the case in choosing what to read in the past, the number of books on a topic, or journals of good repute are far more limited than the potential of postings to the web. Yet, the web is at our fingertips, and at the fingertips of learners. Hence, the relationship with documents changes in subtle ways that need to be examined in more depth than is possible in this short paper. Suffice it to say for now that some of the key issues involve trustworthiness of sources, mutability of online resources (e.g., in wikis), authorship (e.g., is this “R. Smith” that same as any other “R. Smith” posting), conversation as textual sources (e.g., taking ones evidence from blog postings), disappearance of sources (e.g., when web sites are no longer maintained, when sites move), text as conversation (wikis) and conversation as text (bulletin boards, listservs, email, blogs), and non-text documents as texts (video, multi-media texts). Again, there is an increased role for media literacy, i.e., critical evaluation and (de)construction of meaning for online contexts, and for adults as much, if not more so, than for school-age youth.

Change in relationships with local communities and networks

- What does local mean when learning online? Who is in your community?

The meaning of local changes when learning and participating online. We still live in a local geographically-based community with its own culture, and where we meet face-to-face with friends, family and co-workers. There is also the online community, perhaps several, where we engage with others around work or personal interests. Our online community may be highly local in the sense of personal, as we engage with friends and family online, or local in the sense of regional, as we engage with others about critical events in our locale. For example, during the UK foot-and-mouth disease crisis, the Internet became a lifeline for exchanging information and support about dealing locally with the disease and its impact on the lives and livelihoods of farm neighbors (Hagar & Haythornthwaite, 2005). Finally, we may find that our personal postings are no longer local, but instead have taken on global character as the entire web-reading community.
gains access to our texts. In posting to the open web, what is personal becomes global, and in collaboration with others may also be multi-communal and multi-national.

As many have noted already about the Internet, virtual communities may spread widely across geography while glued together by common interest. For example, BurdaStyle (http://www.burdastyle.com/; Abousteit, 2007) provides a site for sewing enthusiasts from around the world. Building on the company’s offline reputation for sewing patterns and fashion, BurdaStyle provides patterns in an open source manner, i.e., they may be modified, used, sold, and uploaded again to the site. A growing community of BurdaStyle members contribute not only patterns, but also instructional videos and photos sequences for teaching sewing techniques, definitions for a sewing terms dictionary, and discussion of techniques. The features of the site and the efforts of the organizers lay the foundations for a learning community, one that is rapidly gaining critical mass toward self-maintenance. It demonstrates many ways in which enthusiastic amateurs (and some aiming for professional lives) distributed across geography, can come together to create and sustain a learning community.

As the web reaches worldwide, education via the web in increasingly becoming globalized. Different skills are emerging for teaching and for learning on a global scale for a global practice, including how to teach and learn in multi-time zone, multi-institutional, and multi-cultural settings. Asynchronous learning networks (ALN; see the Journal of Asynchronous Learning Networks, http://www.sloan-c.org/publications/jaln/) help with crossing time zones, but local social practices are enacted to deal with time-distributed conversations and learning communities. Multi-institutional alliances are developing that provide opportunity for thinly distributed specialists to share expertise and learn from each other. For example, the World Universities Network (www.wun.ac.uk) supports distributed seminars facilitated through high-end videoconferencing supported through Grid technology. Another example is the Web-based Information Science Education (WISE) program that shares seats in online classes across participating institutions (http://www.wiseeducation.org/).

Through such programs, online skills, knowledge, and practices spread along different geographies than offline learning. Kazmer (2005, 2007) describes how online learners form important learning relationships with both their local-online fellow students and their local-offline work mates and community members. Online learning is simultaneously embedded in the geographically-based community, providing an opportunity for learners to engage locally and to share experiences globally.

With all the emphasis on participation and engagement online, and with taking classes anywhere, anytime, the simultaneous demands of the local context and multiple social worlds continue to be overlooked; they remain an invisible part of learning contexts. Discussion of online learning overwhelmingly concentrates on the world of the class, but online learners are simultaneously juggling commitment in their home and work worlds, often adding a learning as a ‘third shift’ (Kramarae, 2001). Locally, accommodations are made in the physical and social arrangement of home and work to partition learning from these other worlds. For example, parents report carving out at-home space and time for
their online education, requiring others to care for children at that time (Haythornthwaite & Kazmer, 2004). Overall this raises the question of what kinds of boundaries will we need to recreate in our local worlds to reinvent those formally defined physically but now needing to be enacted socially? And, as email, cell phones, and mobile computing increasingly engage us in anywhere, anytime, anyone communication, how will we partition time and attention in our cyber-worlds as messages about work, home, or learning reach us at anytime of day or night in any one of those local physical settings? (For more on juggling worlds, and accommodations made in home settings, see Haythornthwaite & Kazmer, 2004; Kazmer, 2005, 2007; Kramarae, 2001; Salaff, 2004).

Towards an Agenda for Ubiquitous Learning

This paper has briefly addressed some transformations affecting learning that are emerging from social and technical practices around participation, and which are creating a culture of ubiquitous learning that occurs anywhere, anytime and with contributions by anyone. These transformations include less regulated information content and retrieval, changing roles in who leads and who follows as authorities and consumers or learners, and a greater role for the individual in information management, information contribution, and participatory citizenship. Transformations are also occurring in who and where we learn and engage with others. Traditional university instruction changes from the classroom to online or blended (on and offline) classes, from single institutional offerings to classes chosen from regional or global offerings. Learning leaves the classroom and local geography to engage regionally and world-wide in online learning communities, sustained by participation and contributions by and for learners. These are trends to follow, important for understanding local, in-class, on-campus learning practices, and the wider, global, open web, ubiquitous learning happening everywhere and every day.

As this phenomenon unfolds there are a many directions for an agenda to both promote and monitor the progress of ubiquitous learning. The main point made in this paper is to consider both the visible and invisible aspects and consequences of these participatory transformations. An agenda for ubiquitous learning involves understanding its full ecology – from individual contribution to communal practice, from submission to retrieval, from lurker to community leader, and from the local to the global. A movement is already underway that gives enhanced attention to participation, e.g., in discussions of as peer production, participatory culture, virtual communities, and learning communities. Critical media literacy already lays the groundwork for assessment and evaluation of resources retrieved from online sources. But there is still work to be done in understanding participatory transformations and how to prepare individuals to teach and learn in this new culture.

First, a critical retrieval literacy is needed that includes not just notions of whether a source is credible or not, but also whether contributions are being made equally across societal sectors (e.g., considering current manifestations of the digital divide), whether retrieval via available search engines is creating exclusive and exclusionary paths to information (e.g., whether popularity should be the top criterion for relevance).
As individuals increasingly become contributors to the wealth of information and knowledge on the web, it is important that contributions be representative of different histories, experiences, and worldviews. This involves examining the range and breadth of contributions to see how the digital representation of cultures is unfolding online, and encouraging and making possible online representation of a wide range of cultures as well as making room for new cultural expressions. This involves issues of access to contemporary technology, education in use of technologies, creation of culture-friendly sites and resources, and representation in multiple languages.

Education is essential for assessing content and materials online. As noted, new forms of contribution, participation, and organization shifts the work of information assessment and evaluation to the individual user. Moreover, education in the underlying information and technology structures can aid in understanding both how to put information online and how it is likely to be found by others. Critical technology evaluation – from the basics of classification systems to the hidden work of search engines – is an important, if not essential, for the educated poster and retriever of the future.

An agenda for ubiquitous learning also needs to engage with understanding the community networks being created and sustained via the web, and the ecologies of on and offline life and information. Each contribution to a central server also affects locals at each retrieval site, and affects who then finds a common home in that online space. It is of great interest to see how this unfolds as participatory culture takes hold, providing an understanding of participatory communities as well as cultures.

**Readings and References**

For further reading on participatory culture and education see the white paper by Henry Jenkins, prepared for the MacArthur Foundation. For more on peer production, see Eric Raymond on the ‘cathedral and the bazaar’ models of contribution, Yochai Benkler’s *The Wealth Of Networks*, and the work by Lawrence Lessig (http://www.lessig.org/) on Creative Commons licensing (http://creativecommons.org/). For recent papers on participation, transformation and leading trends in education and e-learning, see the *Handbook of E-learning Research* (Andrews & Haythornthwaite, 2007), and literature reviews on the Futurelab site (http://www.futurelab.org.uk/).


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Chapter 5: From Ubiquitous Computing to Ubiquitous Learning

M.B. Twidale

Introduction: The Origins of Ubiquitous Computing

This chapter takes the research area of Ubiquitous Computing and examines it for indications of productive lines of analysis and synthesis in Ubiquitous Learning. As such it views the rich set of issues of Ubiquitous Learning through a single lens, albeit one that allows us to focus in on a certain set of key issues. In taking this approach, the aim is to complement the work of other chapters that address the concept of ubiquitous learning from other very different and frequently richer perspectives. The main argument is that Ubiquitous Computing has a set of concepts about ubiquity, inherent learning issues and challenges that should be borne in mind as we consider the potential directions of Ubiquitous Learning, its potentials and problems.

As computing hardware became ever smaller and cheaper, a number of computer science researchers began to consider the potential implications of this for how we might use computers in the future. The term ‘ubiquitous computing’ (often abbreviated to ubicomp) is used to describe research in applications, resultant activities and the social consequences of having many computational resources per person always to hand wherever you are. In essence the argument was an extrapolation from the history of computer applications and use.

Early computers were very big and very expensive. People were meant to configure themselves to the convenience of these devices. The typical piece of hardware was the mainframe and the typical application was payroll processing for a large corporation. Many people shared the use of a single computer and had to wait their turn for their application to be processed.

The advent of small desktop computers led to a change in attitude exemplified by the name of these devices: the Personal Computer (PC). The idea was that each person would have their own computer, and falling hardware costs made it economic to allocate ever cheaper computing resources to making computer use less effortful and less confusing. The resultant features such as graphical user interfaces made computers accessible for ever widening groups of less technically trained computer users. PCs networked together, first within organizations and later across the world via the internet led to our current state of the networked PC with web access and a variety of mechanisms to support not just personal but also collaborative computer use in the contexts of work, learning, play and everyday life.

The next stage is to move from a vision of one (networked) computer per person to very many (networked) computers per person. This is the idea of ubicomp – where computers
are so cheap that they become mere resources to be drawn upon as needed in a fast, lightweight, ad hoc, rapidly changing manner which people configure and reconfigure as their needs and activities change from moment to moment. A useful analogy may be to think of this transition as paralleling that of certain kinds of production, from the blast furnace (like a mainframe; one big technology needing lots of people to operate and itself operating in turn on huge projects) to the electric-powered lather operated by a single skilled machine tool operative, (PC) and on to office furniture and supplies; a panoply of chairs, tables, flipcharts, whiteboards, stickies, pens, highlighters, markers etc. that like ubicomp are technologies assembled and reassembled minute by minute and are so plentiful that they are left lying around in abundance in the hopes that at times they might be useful resources for human creativity.

Concepts Used in Ubiquitous Computing Research
Mark Weiser is generally credited as the founder of ubicomp in a series of papers in the 1990s (Weiser, 1991; Weiser, 1993; Weiser & Brown, 1996). There are particular aspects of ubicomp that differentiate it from conventional computing at least in terms of emphasis. Some of these are outlined below, and can be used to consider how they might inform our consideration of ubiquitous learning.

Beyond the Desktop
Ubicomp considers uses of computing resources that are not just located in a person’s desktop PC. A ubicomp-enabled room might contain many computational resources that the person may want to make use of at different times, including large wall-mounted displays, horizontal tabletop displays, laptops, PCs, tablets, PDAs, and cellphones, as well as control over audio speakers, lighting and heating. Conventionally we consider each of these as being separate devices, but within a ubicomp perspective, they are all considered computational resources that may be combined and recombined in many different ways as people’s activity changes minute by minute. Thus we go from a consideration of software to roomware (Prante, Streitz & Tandler 2004). Although all the devices may be connected together into a single network, the people using them should not have to think of them as a vast complex whole, but rather as a set of combinable, configurable parts.

Mobility
Another part of a consideration of computer use beyond the desktop is the acknowledgement that people in their jobs move around – within a room, from room to room, sometimes from building to building, and even out of doors. This blindingly obvious fact seems to have been somewhat overlooked in much traditional work on PC applications that upon reflection seem to have a built-in assumption that users work all the time at a single desk. A consideration of computer use beyond the workplace and into the domestic and social spheres merely emphasizes this truism of innate mobility. How can technologies and applications support various kinds of mobility? We already see indicators in the ever growing popularity of cellphones, PDAs and laptop computers. Another aspect is the growth of wired and especially wireless connectivity enabling people to access both public and private resources from a range of different locations, rather than only when sitting in front of a particular PC.
Sociability
The personal computer that came into widespread use in the 1980s was in many ways a device supporting applications that seemed to assume a rather solitary form of living and working. The field of Computer Supported Cooperative Work (CSCW) developed in the late 1980s explicitly challenged these assumptions and investigated how networked PCs could support more collaborative forms of working, acknowledging that much work was in any case already inherently collaborative. CSCW research drew not just on computer science, but also on other disciplines such as sociology and anthropology to inform the design of applications that were truly useful, usable and acceptable in supporting collaborative interactions between people. The research area of Computer Supported Collaborative Learning (CSCL) drew on CSCW theory and applications and combined it with insights on collaborative aspects of learning from educational theory. As CSCL drew productively on CSCW, so Ubiquitous Learning may be able to draw productively from Ubiquitous Computing.

Integrating the digital and the physical: mixed reality
A consequence of acknowledging mobility and sociability is a recognition that use of technology should not be divorced from where it happens and the other resources around it. In order to integrate technologies into their lives, people need to integrate them with other things. This includes paper, whiteboards, buildings and other physical devices. A tighter integration allows people to enjoy the advantages of both digital and physical artifacts. In particular, there is a growing body of work within ubicomp looking at the potential of tangible computing - a range of input and output devices that exploit our senses of touch, position, orientation, muscle memory and kinesthetics both to allow very precise control of physical tools, and gestures for the benefit of others.

Multiple tangible computing devices can serve a variety of different complex purposes while retaining the relative simplicity in use that comes from each device being designed for a single purpose. Thus in educational settings, rather than designing a single piece of software to run on a PC or laptop, children learning environmental science may be given a number of different devices that separately act as light and moisture probes, that aid in plant identification, and that support data collection and analysis, and support communication and discussion about evolving conceptualizations (Rogers et al. 2004). Findings from use studies show that a multiplicity of devices is in fact relatively easy to learn and use (because each device only does one or a few simple things) and that the various devices in concert encourage (even enforce) a more collaborative and reflective approach to learning through their coordinated use. Embodying computational elements in physical elements such as wooden blocks and pieces of card allows for the development of augmented reality systems that combine the ease and sociability of combining and rearranging physical elements with the added functionalities and alternative visualizations that computation can provide (Rogers et al., 2003 Price & Rogers, 2004).

Sensors, networks, data and displays
As devices become ever cheaper, it becomes feasible to instrument the world with millions of data sensors (Greenfield, 2006). This allows for more intelligent use of energy in buildings, and various kinds of safety monitoring as well as new ways to undertake science, as each small monitor’s output is networked and integrated with those of thousands of others over, say, an entire river system. Vast amounts of data can then be collected very cheaply, which creates new challenges for storing and interpreting it, using yet more ubicomp devices to support various kinds of visualization and collaborative interpretation.

**Data capture and access**

It is not just information about the physical world that can be collected and stored. So too can information about human activity – what you have seen, which data you used, who you talked to and what was said. The growth of email archives and security camera data are early indicators of possible uses – and their consequences both for good and for ill. Such accumulation of data, its indexing and ease of access opens up opportunities for very beneficial data mining and the augmentation of human memory, as well as more dystopian losses of privacy, security and trust. Something as seemingly benign as videorecording a lecture and allowing students to rapidly index the instructor’s speech, powerpoints, drawings, and text Q&A can be a great enhancement to learning in enabling students to concentrate on the rich picture and allowing more focused review of just those parts of a lecture that they need to attend to. Yet it can also be a risk to some learners, perhaps leading to a complete absence note-taking and a disengagement from the learning experience (Abowd, 1999; Brotherton & Abowd, 2004).

**Context awareness**

Devices that can use information from sensors can respond more appropriately in different settings. Location is one kind of context awareness receiving much attention, but there are many others including a sense of time, and other people and devices present. With location awareness, it becomes possible for a PDA-like device to provide information to a tourist about nearby buildings. With additional information gathered over time, the system may tailor the information presented in response to the user’s reactions to that information.

**Reconfigurability**

People will need to incorporate all these devices and resources into their lives, combining devices in perhaps unanticipated ways in order to achieve their real life goals. The technological infrastructure needs to support arbitrary combinations and reconfigurations of resources, as people appropriate technologies for their own purposes, using them in ways that the developers need not have originally planned. This support needs to be able to cope with the frequent appearance of yet more devices, some of which are enhanced versions of older ones while others offer new kinds of input, processing or output. In this way, end users become co-developers of their computing spaces rather than passive consumers of pre-planned technologies. Of course, this is still mostly science fiction, but developers acknowledge that people will need the ability to reconfigure ubicomp resources in their homes and offices just as they have the ability to reconfigure their rooms’ furniture and paper-based informational resources. Much current work in this area
focuses on interconnection standards and ‘middleware’: software that allows devices to communicate and share resources. The next challenge is to develop interfaces so that end users can exploit this potential for rapid lightweight dynamic reconfiguration.

**Ambient Computing**

As computers become ever cheaper and more plentiful, it becomes possible to conceive of more ‘wasteful’ uses for them. In the early days of computing, processor time was so valuable that humans were expected to work hard to maximize the value extracted from the computer, which consequently demanded their full attention, often just to keep it running. Ambient computing is the opposite extreme – where hardware and processing and display resources are so low cost that it makes sense to provide information on the off-chance that a person might be interested. Early examples already in widespread (and almost unconsidered) use include clocks, traffic reports, informational kiosks, etc.

**Everyday Computing**

Everyday computing (Abowd & Mynatt, 2000) considers the more diffuse uses of computing resources over far longer stretches of time (days, weeks and years rather than seconds, minutes and hours). In these timeframes, people are doing many different things, but each of these individual activities are part of larger activities that persist and interleave. In such a view it can help to consider people having a densely interwoven skein of multiple continuing uses of computer applications for different work, personal, family, health, financial, social and other purposes, that keep interrupting each other and being resumed. This very different view leads to a very different perspective on the design of interfaces and functionalities than the more precisely drawn activities that have a clear beginning, middle and end that have been the focus of much optimization in workplace computing to date.

**Dissolving boundaries of work, learning, play, domesticity and public life**

Even in these early days of ubicomp, we see interesting blurring of boundaries. Widespread adoption of computers, cellphones and high bandwidth networks has already lead to greater porosity of our work and domestic lives. We may work from home, we may shop at work, we may be expected to be on call at all times. Students are offended if we fail to reply to an email sent at 5pm on a Friday before 9am on a Monday. Such porosity clearly has many advantages and disadvantages. And we are only just beginning. What happens as we acknowledge the far greater intermingling of learning, work and play? We already have learning organizations, and organizations channeling playfulness into innovation and design of new products and services. Computer games may be learning devices, training devices, even military recruitment devices. There are serious games conferences, serious play, serious leisure, amateur historians, older people adopting 'hobbies' to stay intellectually alert and interested in life as they contemplate 30 or more years of activity after conventional retirement ages. 'Hobby' seems a misnomer for an activity if you devote 20 years to it- even if you may not have formal qualifications in it. What emerges as we consider interactions as being almost always mixtures of learning, work and play whose proportions might be manipulated?
From Ubiquitous Computing to Ubiquitous Learning
What can we bring to a discussion of Ubiquitous Learning from some 15 years of research in Ubiquitous Computing? Many of the issues translate fairly straightforwardly:

More devices, more possibilities
Traditional education can be enhanced by more computational resources, including those currently only affordable in research labs. This is the same route that standalone PCs have followed, becoming every year more and more powerful, but this time it applies to a multiplicity of different devices. New kinds of learning experiences can be developed by combining resources: large displays and tablet PCs, remote sensors and powerful data visualizations, always available digital libraries and collaborative applications. As personal devices such as cellphones (Mitchell et al., 2005), PDA, ipods and their inevitable successors become more prevalent, it becomes possible to consider educational experiences that use not just a particular one of these technologies, but interesting combinations of them (Moher et al., 2005; Moher, 2006).

From Roomware to Classroomware
Work on ‘roomware’ in workplace settings can be drawn on to consider the potential for ‘classroomware’ in educational settings, where both consider how a variety of different input and output devices can be flexibly and rapidly combined and recombined to meet different purposes, such as smooth transitions between individual work, small meetings, larger plenaries, and back on a minute by minute basis (Peiper et al. 2005).

Reconfigurability of learning resources
Just as current teachers draw on a rich set of non-computational educational technologies and resources amassed in a regular classroom – and the supplies cupboard – so may teachers in a ubicomp environment rapidly assemble a set of technological, physical and informational resources for a particular classroom activity, and then reassemble them for a different activity. Skilled teachers drawing on a wealth of personal and professional practice have been able to do this with a mass of paper and artifactual resources for decades. Currently doing anything similar with arbitrary collections of computational resources is beyond the capability of even the most skilled and well-resourced hacker. But as with ubiquitious computing, so ubiquitous learning will require radical reconfigurability if it is ever to be successful.

Sensors
Cheap sensor data can be shared easily and cost effectively, should the people collecting it so desire. Also, as sensors become ever cheaper it is possible for schools to acquire them both for their own use and as part of a larger federated research endeavor. These falling costs, potentially leading to a ubiquity of data, creates new educational opportunities for more kinds of people including students to be involved in research activities.

Sociability, tangibility and context awareness
Collaborative software allows for more kinds of project-like learning activities, exploiting the configurable resources noted above (Hwang, G-J. 2006). Mobile devices
with appropriate context-awareness creates the potential for highly tailored situated learning experiences (Ogata & Yano, 2004). This aligns with approaches in educational theory dating at least back to Dewey. However educational technologies and particularly technologies appropriated for educational use do not necessarily fit ideally in a use context without further refinement. A piece of chalk in the hand of a gifted teacher is not merely an input device used to apply marks onto a large output display unit called a blackboard. It also serves as a means of gesture and emphasis and its use is interwoven with speaking, pointing, moving, glancing etc. Chalk has its problems, but it is much more flexible in use than many current computational tools intended for educational use, where the intended use is clearly to use just that sole application, concentrating most of your attention on enabling it to do something amazing. The challenge in designing for ubiquitous learning is to consider how ubiquitous computing tools can be incorporated, but may need to be changed. A tool that is optimal for computer supported cooperative work, may be suboptimal for computer supported cooperative learning, because the goals are different. In the former the participants know how to do the task and want to do it as quickly, safely, productively and as well as possible. In the latter, the participants need to learn about the task and how to do the task, and maybe doing the task slowly and badly and thinking about what happened is the more efficient leaning activity even when it is not the most efficient working activity.

Beyond the desktop and beyond the classroom
There is a rich tradition of innovative educational computing at a desktop in a computer lab. Ubicomp can provide additional resources to add to such experiences, but it can also encourage us to consider to applications supporting use of in other locations: still at school, on fieldtrips, at home, and in yet more settings (Schnädelbach et al. 2004; Halloran, 2006). Ever smaller devices permitting the integration of computing applications (and hence potentially learning) into small niches of time, while waiting, while using public transport, etc. As e-learning led to a reconsideration of learning from other locations than the classroom (but still desk based) so m-learning raises the options of some kinds of learning occurring in even more mobile settings (Keegan, 2002). There is also great potential for supporting different kinds of learning in different kinds of context: not just formal education K-PhD, but also workplace learning, leisure learning, serious play, learning for the elderly, learning in domestic contexts of family health, finance, politics, environmentalism etc. Just as ubicomp leads to notions of more informal everyday computing, how might ubilearn lead to notions of more informal everyday learning? Some of this learning may itself be very lightweight, perhaps even ambient, but much of it will remain the sustained concentration we more commonly consider. However ‘ubilearn’ has to acknowledge that it gets interrupted and interwoven with other activities and may perhaps be more usefully considered in the longer timeframes that ubicomp has been forced to address.

Learning to use ubicomp itself:
This is an issue that deserves far greater attention than it currently receives. It can get overlooked both by computer scientists and by educational researchers. The former may be more interested in the functionality of the system or in how people use the system in their lives after initial learning has (somehow) happened, while the latter may be more
interested in the use of the technology to support the learning of another more important topic (physics, literature, medicine) than in how people learn how to use the technology itself.

Nevertheless, the learning of ubicomp applications is just as interesting a challenge as learning with ubicomp applications. It is likely to remain a challenge, perhaps even a growing one, for a number of reasons: as new devices are developed for new uses, employing new ways of interacting, people will have to learn how to use them. Despite the best efforts of human computer interaction researchers, few interfaces are as ‘intuitive’ as they are claimed to be. The term ‘intuitive’ is itself somewhat problematic – few people actually intuit how to use the interfaces. They normally employ some learning process that is often overlooked. Applications are also upgraded with slightly different features and interfaces, and replaced by rival products. Adding to the complexity, as ubicomp devices are tailored and combined in new ways, those uses-in-combination themselves also have to be learned.

Clearly, good interface design can lower some of the barriers to learning, but they are unlikely to completely obliterate them, particularly as access to devices is broadened to a wider audience. Learning in various ways needs to be supported. This needs to include individual learning, (ranging from consulting manuals, help systems, hints, wizards etc., to fiddling and experimenting with the device) as well as more social learning. Social learning in turn can range along levels of formality from organized training sessions through various kinds of local and remote technical support using a variety of communications media (telephone, bulletin board, instant messaging etc.), and on to informal help and advice from peers or family members.

Over The Shoulder Learning

Over The Shoulder Learning (OTSL) is a body of work looking at informal peer help-giving, initially concentrating on interactions between adults in the workplace (Twidale, 2005). Extensions to the work have looked at similar interactions in formal learning, for leisure, amongst children, and virtually (Twidale & Ruhleder, 2004a&b; Twidale, Wang & Hinn, 2005; Singh, Twidale & Rathi, 2006). The claim is that a consideration of informal learning teaching and help-giving such as this grows in importance as computing becomes more ubiquitous.

The focus of OTSL is informal help on how to use computer applications. Informal help is used both when people initially learn to use an application, but also in subsequent incremental learning of more sophisticated use. Clearly OTSL is a kind of CSCL, but also is in many ways substantially different from typical CSCL applications and interactions. The ideal interaction is incredibly brief (minutes, even seconds) and deeply interwoven into a larger (usually work) activity.

OTSL is an easily recognizable phenomenon – one that many people spontaneously do. It can be as simple as calling over a friend and asking for help on formatting a page in
Microsoft Word and being shown or talked through a series of interaction steps. In studies of OTSL in a variety of different workplaces, the most minimalist yet still effective help noted was the yelling of a single word across a corridor between offices – the name of the command in the application that would do the action that the help-seeker had asked about.

The following transcript from a videotape made early in our research illustrates OTSL in action. It shows one colleague (T) helping another (L) to create and upload a webpage. The decision to videotape for deeper analysis means that the interaction was less spontaneous than those observed in our ethnographic studies, but the interaction itself was very similar to the more authentic ones we observed in a variety of settings. The participants had been planning to do the help activity and scheduled it when videotaping was possible.
(Points) Now that’s your official and there’s your personal. We can do this in several segments and I think we should do that bit last. So first of all we’ll get the file you’ve created up on the web and we’ll test if that works.

And then we’ll link it.

And then we’ll link it. So when we first put it up only people who know its exact URL will be able to get to it. But then we can link to it from this page (points) which will make it much more accessible. We’re now going to go…

Back to FTP

That’s right.

Right. So, this is…

It’s that one (points), “.htm”.

So I just click on that and it goes across.

You click on it and then you click on that (points)

It’s on (mumbling) (Does a series of clicks)

I didn’t know you knew how to do that!

Oh, yeah!

Ahhh!

Well I remembered that.

Very nice. Right, so it’s there, so let’s test if it’s really there or not. So if you go back into this here…that’s right. Click on that one, (point) that window you’re in. Now if we can edit this URL…just move the cursor to the end of this (points again) and click again…so…no, don’t click…just click on the cursor again, that’s right. And now I want you to delete up to that slash there, OK. Now type in “filename.htm”

It isn’t there…

Oh, you need to (points out typo in URL, L retypes)

Isn’t there a way of calling this up so that we can have a window that lets you choose the file? Because I always forget what I call these things.

Yes, there is, this is just a quick test. So press return…

Oh dear.

It says it hasn’t found it. So let’s go back to FTP to see what went wrong.

Is it case sensitive?

Um, it might be…

Oh, I know, don’t we have to refresh or something like that.

Sometimes you do, but go back here. I don’t think the refresh in this case because…Let’s try…Of course I can’t remember if the .htm was capitalized or not, so click on the FTP. See if it was.

No, it wasn’t.

Hey, we just got rid of it again.

So it won’t accept things in lower case then.

Type it in again, I’m a bit suspicious. I don’t know why it lost those capitals.

Oh, there it is.

Oh there it is…you were right, it is case sensitive. So now, have a look at this, see if you like the look.

So this in…

This is in html.

It’s awfully wide.

That’s OK. It expands to fill the size of the screen.

Oh, OK. I probably should have broken it up but that’ll do for now.

That’ll do for now. So I think the thing to do now is switch back to this. Let’s…It’s a bit confusing because of this case, so I would say it’s probably better to rename everything to lowercase just so you don’t have any confusion in the future. So if you select it (point) and click on rename (L does so). That’s right. (points) That’s the one that’s stored on your machines that’s up on the web.
It is worth noting that the interaction is far more freeform than a conventional education or training process. The help-seeker has a task they want to do and the help-giver is guiding them through it. So the help-giver is not really delivering a classic syllabus, but is using their expertise to guide and scaffold the interaction, and to explain some additional aspects of the meaning of some of the steps. The interactions observed were very rarely simple instructional monologues of the form: “Do that, do that, do that ... there, you’re done”. Interactions were much more conversational and dynamic. Also, things often go wrong. Sometimes the teaching/helping is suboptimal and has to be revised. Sometimes the advice is wrong or something happens that needs to be corrected. This can be due to an error on the part of the help-giver or some external artifact making the desired goal more complicated to achieve than first expected. Often this is because of earlier failed attempts at doing the task prior to asking for help that have added to the complexity of the solution. Now it’s necessary to undo prior incorrect, often misremembered or forgotten steps as well as do the correct steps.

As we discovered as our study progressed, this transcript contains elements that recurred in many interactions that were not quite what we had expected to find. We had anticipated seeing teaching episodes of varying quality and effectiveness, helped or hindered in various ways by the functionality and interface of the application under discussion that would inform our analysis and design of better support technologies and best practice for help giving. In particular we were sensitive to people struggling to remember the help they had been given. We certainly saw those issues, but we also observed learning-teaching interactions merging back and forth with collaborative problem-solving, and considerable use of multiple applications, adding to the complexity of the interaction. Additionally the transcript reveals issues we encountered in several other sites of people having to cope with navigating multiple virtual locations and having multiple online logins, identities and passwords – the “Where am I and Who am I?” problem (Twidale & Ruhleder 2004b). These issues become even more pronounced in ubicomp settings. The transcript gives a flavor both of the messiness and the power of informal help giving that we observed throughout our study.

Although fast, fluid, flexible and deeply contextualized, OTSL often has to battle to compensate for poorly designed applications. Sometimes this is a matter of overcoming poor interface design, such as an interaction explaining which icon to click on to have the desired effect, and an associated warning not to click on a very similar-looking icon that does something different. With better user testing and analysis, the need for that kind of interaction could have been oblitered, by the user guessing and learning from an interface with better designed icons, and more informative hover-text. However the need for approaches like OTSL are likely to remain, due to the highly contextualized nature of work. For example a request for help on creating a sales report can involve not just a discussion of which sequence of buttons to click in Microsoft Word, but also aspects of the corporate culture and expectations about the content of the report that even the most expert Microsoft technical support hotline could not possibly address.

Furthermore, the study revealed a substantial use of multiple applications in order to do a given task. A report may be written in MS Word, but involve data copied and pasted from
a spreadsheet, some from public web pages and other items from corporate databases and intranets as well as files emailed back and forth containing modifications by colleagues. This means that a request for help may necessitate a diagnosis of a problem that extends over two or more applications as well as a consideration of the operating system and the file system The explanation may be a sequence of actions in different applications or even the opening of yet another application in order to construct a workaround. This reminds us that even in very conventional desktop applications, users do not passively consume software. They innovate in their use of applications by composing flows of work, copying and pasting resources between applications. This is done even by people who vociferously claim to be “no good at computers”, and yet are making se of computational resources in innovative ways without the need or the ability to program. Again, we see this as a foreshadowing of the potential of ubiquitous computing – provided people can learn how to use an innovate with a large set of resources.

An OTSL episode can veer unpredictably between teaching, collaborative problem-solving and co-discovery. The help-seeker may have asked a particular colleague because he expects that she already knows the answer, but it can turn out that they both have to work together to solve the problem, both learning as they do so.

This kind of informal peer learning/teaching/helping can be considered as yet another example of ‘wikification’ (Tapscott & Williams, 2006) – the growing awareness of a widespread phenomenon (predating computers, let alone web 2.0 technologies) of informal mechanisms co-existing with formal ones. In the case of ubiquitous learning, it leads us to consider how such informal kinds of learning do not and should not replace formal education and training, but can powerfully supplement it. Currently however, the informal and formal learning episodes are rarely studied by the same people, using a similar set of analyses and theories, and so rarely used to inform each other in terms of pedagogic strategies and computational design implications.

Designing to support collaborative learnability
A challenge for Human Computer Interaction (HCI) design in a world of ubicomp is to consider how to support not just its conventional focus on individual learnability but also collaborative learnability. Currently we have some applications that seem to support collaborative learnability by accident rather than by design. For example, text messaging on cellphones has exploded in usage since its first introduction. From the perspective of traditionalist individualist HCI, the interface to text messaging is highly problematic – on most phones it is fiddly to learn how to use it effectively, indeed at all. The fact that hundreds of millions of people have bothered to learn (while other hard to learn applications are ignored or abandoned) shows its utility and how this can compensate for poor usability.

However, if we consider the interface from the perspective of how it affords collaborative learnability, it does have powerful compensatory features. It may be fiddly to learn on your own, but it is much easier to learn socially if someone shows you and sends you messages to practice on. The very portability of cellphones affords micro-learning episodes in settings far removed from formal classrooms – sitting together on a sofa, in a
café or a bar for example. Similarly, Unix has many rather surprising affordances for collaborative learning, despite being highly problematic in terms of individual learning (Twidale, 2005).

As noted, as computer applications have been extended in their uses and context, computer scientists have worked with more kinds of disciplines in order to support design. With a move towards PC applications for non-experts, cognitive psychologists have added to our understanding of HCI. With a consideration of collaboration, sociologists and anthropologists have added to our understanding of how people interact with each other. With a growing awareness of the learning burden implied by a flood of new technologies and new applications, and an awareness that ‘intuitiveness’ is an aspiration, but not something we can reliably construct, there is at least the possibility that experts with a background in education, learning and teaching can help inform the design of more learnable, particularly socially learnable applications.

**Conclusion**

Ubiquitous computing is emerging as a body of research in computer science that draws on many other research traditions to inform its analysis. It is much more than a study of novel gadgetry. Much of the research is innovative and playful, exploring the potential of radically new technologies by developing weird and wonderful proofs of concept that at time seem designed almost as pieces of conceptual art – pieces designed to provoke a reaction, change perspectives and initiate debates, rather than as polished final products. Many of these early proofs of concept will turn out to be research dead ends, and yet may inspire more fruitful applications and conceptualizations.

All this lively exploration and experimentation is in part an acknowledgement that as computing pervades people’s work, personal and social lives, traditional reductionist lab-based research methods are insufficient, and the very methods of doing research need to be redesigned along with the technologies that the research is intended to inspire – and indeed is inspired by.

This raises many interesting opportunities for reconsidering how learning has a role to play in this ferment. Ubiquitous Learning can be about adopting, or appropriating ubicomp technologies for use in traditional educational setting such as classrooms, or it may be about the alignment of ubiquitous computing with more ubiquitous contexts of learning, outside the formal classroom; in the workplace, in the home, in public places, everywhere. These are not new ideas for educational theorists, indeed they are issues raised by progressive educators for decades. The ideas are still big – it’s just the gadgets that have got smaller.

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PART B: Contexts

Chapter 6: Notes toward a Political Economy of Ubiquitous Learning

Michael A Peters

The body is our general medium for having a world
--Maurice Merleau-Ponty

Introduction

Substantial claims are currently being made for ubiquitous learning (UB). It is seen as an emergent new set of revolutionary learning technologies that is to be distinguished from conventional IT-aided learning, e-learning and distance learning, through its utilization of new mobile technologies for the construction of collaborative, distributed, often peer-to-peer, learning platforms. Thus, for instance, Ellen D. Wagner (2005) in EDUCAUSE Review claims ‘The mobile revolution is finally here. Wherever one looks, the evidence of mobile penetration and adoption is irrefutable. PDAs (personal digital assistants), MP3 players, portable game devices, handhelds, tablets, and laptops abound. No demographic is immune from this phenomenon.’ The strengths of UB follow from its pervasive utility. It is said to possess a family of distinguishing features that emphasize accessibility, ‘access from anywhere at any time’; interactivity, including interaction with experts or peers in synchronous or asynchronous communication; immediacy with potential for quick information retrieval and storage; permanency with an accent on continuous and instant recording; and everyday situatedness, where learning embedded in everyday life) (Chen et al, 2002; Curtis et al, 2002; Ogata & Yano, 2004). It is claimed that on the basis of the new mobile technologies learners will be able to select the best means for learning from the available alternatives (including conventional means) depending upon time, place and other critical factors and that they will, therefore, ‘be able to learn at any time, any place, as and if they wish’ (Ogata & Yano, 2004).

Developments are seen as part of a set of wider trends that as Judy Brown (2006) puts it ‘Everything is connected; Everything is aware; Everything is digital; and, Everything talks to everything’. These trends will be enhanced as the size, battery life and cost diminish, while power, connectivity and capabilities increase. Mobile learning technologies are not limited simply to handhelds but encompass a range of different devices and technologies. Brown (2006) provides a useful classification of mobile technologies in the slide below.
The general ethos of the emerging core of UB is alleged to make full use of Web 2.0 as platform and to exhibit the following characteristics: rich learner-user experiences, learner-user as contributor, learner-user self-service, learner controls own data, radical trust, and is sometimes referred to in a series of contrasts with Web1.0 — tagging not taxonomy, participation not publishing, Wikipedia not Britannica online, DoubleClick not Google AdSense, mp3.com not Napster, search engine optimization not domain name speculation, syndication not stickiness (O’Reilly, 2005).  

Major claims have been made concerning the distinctiveness of this set of new learning technologies. They are claimed to be part of a world-wide proliferation of wireless handheld devices (WHDs) that in turn help to support the trend towards ubiquitous commuting, ‘the potential of WHDs to enable sophisticated types of instructional designs’ and ‘WHD’s fostering of new, media-based learning styles’ (Dieterle et al, forthcoming, p. 1). New learning styles propagated by WHDs promote ‘fluency in multiple media’ where ‘Each medium, moreover, is valued for the types of communication, activities, experiences, and expressions it empowers, evading functional fixedness and over-reliance on one preferred medium’. Further, these new learning styles ‘capture learning based on collectively seeking, sieving, and synthesizing experiences rather than individually locating and absorbing information from a single best source’ and ‘value active learning based on experience (real and simulated) that includes frequent opportunities for reflection’ (Dieterle et al, forthcoming, p. 19).

As an additional reason for taking ubiquitous learning seriously, apart from its situated ubiquity, flexibility, and contextuality, is the fact that ‘Informal learning using mobile

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1 There have been doubts raised whether Web 2.0 is a coherent concept although weblogs, wikis, podcasts, RSS feeds, social software and online web services do seem to indicate a change in web usage.
technologies is already embedded in our daily lives’ as the author of a report to the Australian Government suggests (Peters, 2005, p. 1), thus promoting a strong relationship of education to the workplace. She goes on to observe:

 Millions of web-enabled phones are being used by learners (who may not be enrolled in formal courses) to seek information to build their own knowledge base. Use of mobile phones, PDAs and laptops in organisations is well-established and interviews with employers indicate that m-learning is integrated with the use of these mobile technologies at the workplace (p. 1).

And she concludes:

 With consumers driving the global uptake of mobile telephony, and the growing functionality of these devices, it appears that m-learning is here to stay. Managing m-learning as a part of a suite of services that offer greater choice to learners will have benefits for providers as it frees teachers from delivery to focus on the management of learning, and will help learners to gain the skills needed by knowledge workers in the new economy (p. 1).

This paper accepts both this broad description and the promise of new mobile learning technologies (UB) but inquires into its technological enframing and its underlying philosophical, political and economic framework suggesting some reasons for caution as well as recognizing its promise. The paper also raises a series of brief criticisms that are intended to serve as reasons for caution.

**Locating Ubiquitous Learning in the History of the Emergence of New Media**

We now live in a socially networked universe in which the material conditions for the formation, circulation, and utilization of knowledge and learning are rapidly changing from an industrial to information and media-based economy. Increasingly the emphasis has fallen on the ‘learning economy’, on improving learning systems and networks, and the acquisition of new literacies as a central aspect of development considered in personal, community, regional, national and global contexts. These mega-trends signal both changes in the production and consumption of symbolic goods and also associated changes in their contexts of use. They accent the learner’s co-production and active production of meaning in a variety of networked public and private spaces, where knowledge and learning emerge as new principles of social stratification, social mobility and identity formation.

Communication and information technologies not only diminish the effect of distance; they also thereby conflate the local and the global, the private and the public, ‘work’ and ‘home’. Digitalization of learning systems increases the speed, circulation and exchange of knowledge highlighting the importance of the digital archive, digital representations of all symbolic and cultural resources, and new literacies and models of text management. At the same time the radical concordance of image, text and sound, and development of
new information/knowledge infrastructures have created new learning opportunities while encouraging the emergence of a global media network linked with a global communications network together with the emergence a global Euro-American consumer culture and the rise of global edutainment media conglomerates. The question, therefore, of who owns and designs mobile learning systems is of paramount political and philosophical importance for ‘How a system is designed will affect the freedoms and control the system enables’ (Lessig, 2002: 35).

Ubiquitous learning and the new mobile technologies are part of the larger framework of e-learning which itself can be located within the model of flexible learning (Peters, 2005). Further, these nesting technologies can be seen as part of wider historical emerging technology systems that promote greater interconnectivity and encompass all of its different modes that characterize communication from the telegraph (city-to-city), the media (one-to-many), the telephone (one-on-one), the Internet (one-to-one, one-to-all, all-to-one, all-to-all, many-to-many, etc.), the World Wide Web (collective by content but connective by access), the mobile/cell phone (all the interconnectivity modes afforded by the web and internet, plus a body-to-body connection).

Questioning the Value of Ubiquity

There are many accounts of ubiquitous learning that extol its virtues and few that raise possible questions and mention the dangers that it might also represent. In presentation after presentation I have witnessed what might be called ‘technical presentations’ that enumerate the capacity and properties of various devices and applications, without a moment’s contemplation of context. Nearly everyone agrees and takes for granted that the value of ubiquity is primary and also significant. There are very few accounts that seem to want to question its primary value or what we might call the ‘metaphysics of ubiquity’. Yet to quote a line of the Beatles’ song ‘you’re everywhere and nowhere, baby!’; ubiquity has no home, no place, no belonging. From the Latin ubique the word carries the meaning ‘existence or apparent existence everywhere at the same time’.

The critique of the value of ubiquity is perhaps best articulated by Hubert Dreyfus whose analysis of the Internet is not yet another contribution to the hyper-instrumentalist discourse typified by a ‘gee-wiz’ ethos touting efficiency gains and the lasting technical transformation of education. Dreyfus lines up with Nietzsche, Kierkegaard, Heidegger and Merleau-Ponty, a group of philosophers who were dedicated to overcoming the dualisms ruling Cartesian thought and who argued for a phenomenology of the body and its central importance in human learning. He succinctly sums up his thesis in the final paragraph:

as long as we continue to affirm our bodies, the Net can be useful to us in spite of its tendency to offer the worst of a series of asymmetric trade-offs: economy over efficiency in education, the virtual over the real in our relation to things and people, and anonymity over commitment in our lives. But, in using it, we have to remember that our culture has already fallen twice for the Platonic/Christian
temptation to try to get rid of our vulnerable bodies, and has ended in nihilism. This time around we must resist this temptation and affirm our bodies, not in spite of their finitude and vulnerability, but because, without our bodies, as Nietzsche saw, we would be literally nothing (Dreyfus, 2001, pp. 106-7)

It is a thesis as powerful as it is frightening, as simple and elegant as it is prophetic. The Net as a kind of technological enframing of being stands at the door. It contains both the danger and the saving power. If we allow it to transcend the limits of the body we will also allow it to abstract from our moods, our cultural location and belongingness, our finitude and vulnerability, our animality that helps comprise our linguistic and cultural identities, and also the meaning we give our lives. By leaving the body behind we will succumb to the same nihilistic impulses in our culture that began with Platonism and was repeated by Christianity.²

**Propriety and Nonpropriety Forms of Ubiquitous Learning**

An argument from critical political economy suggests in essence that ubiquitous learning is the quickest way of handing public education over to the new technoscientific global information conglomerates whose profit margins dictate planned obsolescence and an endless product cycle of innovation and fashion. The clearest example here is the potential of educational television the promise of which has been eclipsed partly because broadcasting in the U.S. developed as a commercial entity. As the website of The Museum of Broadcast Communications explains

> Within this system efforts to use the medium for educational purposes always struggled to survive, nearly overwhelmed by the flood of entertainment programming designed to attract audiences to the commercials that educated them in another way--to become active consumers. Despite its clear potential and the aspirations of pioneer broadcasters, educational television has never realized its fullest potential as an instructional medium ([http://www.museum.tv/archives/etv/E/htmlE/educationalt/educationalt.htm](http://www.museum.tv/archives/etv/E/htmlE/educationalt/educationalt.htm)).

The very pervasiveness of the new learning technologies constituting ubiquitous learning collapses the distinctions between home and work, school and leisure, public and private, school and work, formal and informal education and delivers the school into the hands of an endless commodity cycles that have little to do with the aims and purposes of education.

In a study of how social production transforms markets and freedom, Benkler (2006: 1) begins his authoritative work with the following words:

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² Dreyfus is a long-standing critic of computer ideologies and, in particular, the cognitive science modelling of the brain on the computer in books like *What Computers Can’t Do* and *What Computer Still Can’t Do* (Dreyfus, 1972; 1992).
Information, knowledge, and culture are central to human freedom and human development. How they are produced and exchanged in our society critically affects the way we see the state of the world as it is and might be; who decides these questions; and how we, as societies and polities, come to understand what can and ought to be done. For more than 150 years, modern complex democracies have depended in large measure on an industrial information economy for these basic functions. In the past decade and a half, we have begun to see a radical change in the organization of information production. Enabled by technological change, we are beginning to see a series of economic, social, and cultural adaptations that make possible a radical transformation of how we make the information environment we occupy as autonomous individuals, citizens, and members of cultural and social groups... The change brought about by the networked information environment is deep. It is structural. It goes to the very foundations of how liberal markets and liberal democracies have coevolved for almost two centuries.

Benkler is not alone in making what seem like extravagant claims. His work rests on and is in turn reinforced by a range of scholars mostly working in the related areas of informatics, international law and political economy, including James Boyle, Hal Abelson, and Lawrence Lessig. They concur that the role of nonmarket and nonproprietary production promotes the emergence of a new information environment and networked economy that both depends upon and encourages greater individual freedom, democratic participation, collaboration and interactivity. This ‘promises to enable social production and exchange to play a much larger role, alongside property - and market based production, than they ever have in modern democracies’ (Benkler, 2006: 3). Peer production of information, knowledge, and culture enabled by the emergence of free and open-source software permits the expansion of the social model production beyond software platform into every domain of information and cultural production. The model of social production identified and analyzed by Benkler has its important counterpart and infrastructure in the increasing ubiquity of Linux that ‘has progressed from marginal status as a platform for intelligent devices to a position of ubiquity, even dominance, in embedded design’ (Weinberg, 2006).

Lawrence Lessig (2002) in The Future of Ideas provides a useful model arguing that digital technologies have dramatically changed the conditions of creativity, essential to both new learning and the knowledge economy. For Lessig, the future of ideas and ‘the fate of the commons in an interconnected world’ (the subtitle of his book) is a question of freedom or control in relation to the development of the Internet. Applying the notion of “the commons” to the Internet, Lessig defines the Internet as a communication system comprised of three discrete layers: first, the “physical” layer made up of computers and wires linking computers to the Internet; second, a “logical” or “code” layer that makes the hardware operational, including the protocols the define the Internet and the software on which they run; third, the “content” layer, that is, the material which gets transmitted across the Internet, including the digital images, texts and sounds. As Lessig observes, in principle each of these layers could be either controlled or free: “Each, that is, could be owned or each could be organized in a commons” (p. 23). The question of freedom
versus control is of central importance to understanding the precarious nature of various emerging open knowledge production regimes such as open source, open access and the free science movements and their applications in open learning systems (Peters & Besley, 2006). Open knowledge production is based upon an incremental, decentralized (and asynchronous), and collaborative a development process that transcends the traditional proprietary market model. Commons-based peer production is based on free cooperation, not on the selling of one's labor in exchange of a wage, nor motivated primarily by profit or for the exchange value of the resulting product; it is managed through new modes of peer governance rather than traditional organizational hierarchies and it is an innovative application of copyright which creates an information commons and transcends the limitations attached to both the private (for-profit) and public (state-based) property forms.

Ubiquitous learning offers great possibilities but also presents educational dangers; its technological forms must also be subjected to wider philosophical scrutiny and its emergence, development and adoption in public education must proceed with an understanding of wider questions developed from political economy.

Readings and References


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Chapter 7: Ubiquitous Media and the Revival of Participatory Culture

Jack Brighton

Mass media technologies historically have been controlled by elite minorities. Not surprisingly, the products, authorship, and distribution patterns of media have largely served the interests of their masters. To be sure, many efforts have been made to establish models of public service media in pursuit of the “public interest, convenience, and necessity.” (McChesney, 1993) But domination of media control by political and corporate elites, made possible by the demands of existing media technologies and economies, has largely tipped the balance in favor of private, commercial, and political interests.

The emergence of broadcasting brought consolidation of media control to a new peak, by entrenching a literal “one-to-many” relationship between authors and audience. This model encodes an equation of authorship with authority, and audience with passivity. The technical and economic demands of broadcasting and of “professional journalism” have effectively discouraged participation in media-making by individuals and non-professional groups.

What happens if this is no longer the case? What would it mean if anyone could create, publish, and share media on a global scale? We’re not quite there yet, but the concept of a ubiquitous open media system, for the first time in the history of media, no longer seems farfetched. Several large barriers and contested areas of interest remain unresolved: intellectual property law, proprietary systems and formats, and resistance from established media models and entities, to name a few. But for those of us interested in public service media, we now have enough examples of “participatory ubimedia” to move forward with some confidence, perhaps even hope.

Digital Depression

In early 2003 I found myself in a state of despair over the direction of news media on the Internet. I had just attended the first annual conference of the Integrated Media Association, a sort of think-tank for public broadcasting on the web. The keynote speaker was Merrill Brown, Senior Vice President at RealNetworks, who unveiled the company’s new (and short-lived) marketing slogan “All You Need is One.” That would be the RealOne player, which in Brown’s RealSpeak is a “consumer appliance, not the piece of software.” Actually the RealOne player was more than that. It was an all-purpose digital rights management system, the core of a new media business model. And Brown brought
the announcement of a major new media business breakthrough: an exclusive deal with CNN to stream online news video only through the RealOne paid subscription service.

Many of my colleagues were nodding their heads. We were all scrambling for ways to cover costs for streaming our public radio and TV content. Those costs include expensive servers and lots of bandwidth, which for most public stations could total $1000 to $10,000 per month depending on the scale. The "streaming conundrum" held that the more successful you become at developing an audience for online media, the less you could afford it. If you succeed, you fail. Unless you find ways to make users pay for the service, said Merrill Brown, and suddenly we were talking about subscription models and charging people for public TV and radio content on the web. We were advised by resident gurus and industry consultants to adopt a “shopping mall” model for online media, serving boutique content to affluent customers and low-quality bits for the freeloaders.

I came up in journalism during a time when we considered our work vital to the health of community, democracy, and culture, when our product was in essence not media but informed and engaged citizens. In public broadcasting we're supposed to be shining a light on the world, exploring histories and cultures, and helping people understand other peoples’ stories. You can have that for a monthly charge of $29.95? I couldn't imagine hustling that. Some of us thought the promise of the Internet was to make information accessible, not lock it behind firewalls and logins. We believed public media should be public, and users shouldn’t have to subscribe to it unless it’s a free RSS feed. So we declared ourselves “open content radicals,” and began plotting ways to steer the public broadcasting system toward an open media philosophy. We launched a web site focused on methods of sharing content as “open source media.”(Brighton & Tynan, 2006) We got busy developing a metadata standard and technical infrastructure for publishing and aggregating media collections throughout the public broadcasting system, to make content findable and more useful for audiences everywhere. And we vowed an ongoing conspiracy to undermine the shopping mall metaphor in favor of a public library model for public media on the web.

Flash forward to 2007. Broadband penetration in U.S. homes reached over 80 percent.(King, 2007) In January 2007 alone, 123 million people in the United States viewed 7.2 billion videos online. For ages 18 to 26, Internet use has surpassed television.(Borland, 2007) And at the Integrated Media Association annual conference in Boston in February 2007, no one was still talking about charging users for access to online news. Almost everyone in the public broadcasting system has become focused on how to make content freely available, how to better catalog it and expose its metadata. The BBC plans to put its entire archive online for free, (Robinson, 2007) and we’re taking this as our own mandate in the U.S. We’re now talking about open source web applications, social networking, Creative Commons licensing, and user-generated content. By now even most commercial news organizations can read the writing on the blog. The Chicago Tribune launched a community journalism web site with the majority of its content written by readers. TV news can’t cover breaking events with its own reduced news staff, but it can broadcast cell phone video emailed in by viewers.
Multimedia is exploding on the Internet, mostly created by non-professionals. “With today’s technology,” says filmmaker Michael Wiese, “there is absolutely nothing to stop anyone from having a good idea and expressing it visually.”(News-Gazette, 2007) Adds Wall Street Journal technology columnist Lee Gomes, “Anyone who wants to create a TV channel just needs a computer and a Web address.”(Gomes, 2007) With a growing number of free hosting providers, you don’t even need your own server. Anyone with a valid email address can now publish media. Four years after Merrill Brown’s “breakthrough,” CNN is no longer charging for access to its online archives.

We might call it the YouTube Effect. It certainly had nothing to do with our little open content conspiracy in public broadcasting. The truth is that Merrill Brown and company got it wrong by almost 180 degrees: The online media business model isn’t about serving content to passive consumers through a rights-controlled bottleneck. It’s about people freely creating and sharing stories, passions, and ideas. We are not “users” or “consumers” of online media so much as we are members of a global media community made possible by amazing inexpensive media tools and the interconnection of everything. Put another way, what we used to call The Media has lost control of the media. And if you care about community and democracy, this is a very hopeful turn of events.

But is this dawning of ubiquitous open media for all just another passing moment? Is the very idea of universal and free public media simply the fantasy of a few open content radicals? We still have some work to do, but we can hardly do worse than the era we hope is now passing.

**A Short History of Broadcasting, in Which Media Becomes Unfree**

The phrase “new media” could be applied in many times and places during our experiments with literacy and communications technology. Once upon a time, a new technology called wireless telegraphy was developed by scientists and inventors, credited primarily to Nikola Tesla, Guglielmo Marconi, and Alexander Popov.(Wikipedia, 2007) What we now call radio was understood in the early 20th century as a point-to-point medium, i.e. an improvement on wired telegraphy. By the time Marconi received a patent for the invention of radio in 1904, the U.S. had already been well-wired for telegraphy, and the corporation that controlled most of those wires, Western Union, saw no profit in making them obsolete. But one place where wires couldn’t reach was a ship at sea, so on April 14th, 1912 when the RMS Titanic struck an iceberg, the world learned of the unfolding tragedy by way of a “point-to-point” radio transmission from the ship. The message was received by a Marconi employee named David Sarnoff, operating the wireless telegraph in New York’s Wanamaker Department Store. Over the next two days Sarnoff relayed the names of survivors to a public eager for news, serving as one of the very few “points” of reception from the news source at sea. The experience for Sarnoff was a revelation: If one could expand the number of receivers, wireless telegraphy would no longer be merely point-to-point, but one-to-many. In that instant, the idea of radio as a mass medium was born.
Sadly for open content radicals, the story of radio soon took a proprietary turn. Sarnoff pursued his vision of “broadcasting” at helm of the Radio Corporation of America, a creation of General Electric after its purchase of the American Marconi company. RCA began marketing a “radio music box” for home use, and by 1922 a growing number of “broadcasters” were driving mass demand for the new media device. “A significant percentage of the stations were operated by nonprofit organizations like religious groups, civic organizations, labor unions, and in particular, colleges and universities,” writes Robert McChesney in his classic history of broadcasting in the U.S. (McChesney, 1993)

While Chicago had commercial station WLS (for World’s Largest Store, owned by Sears Roebuck & Co.), it also had WCFL (run by the Chicago Federation of Labor). But the proliferation of radio transmitters run by “amateurs,” schools, and community organizations lead to a conflict over rights to the electromagnetic spectrum on which broadcasting depends. The drafting of the Federal Radio Act of 1927 became a high-stakes contest between a few increasingly powerful commercial radio corporations, and a larger but fragmented group of nonprofit radio operators and enthusiasts. A quick scan through the radio dial today will reveal all you need to know about who won.

But before we jettison radio as a medium for community, education, and democracy, let’s consider what it would take to start your own station today. You must first conduct a frequency search over a 30-mile radius from your intended transmitter site, after which you may (if you find an available frequency) file a Petition for Rulemaking with the FCC with a fee of $1795. Within 90 days, the FCC will issue a public notice called the Notice of Proposed Rulemaking. After a period of public comment, the FCC has nine months to issue a Report and Order declaring an acceptance or rejection of your Petition. If your Petition is accepted, the FCC will open a 30-day auction for the frequency you selected, during which you and anyone else may file a bid (with filing fee) to operate a station using that frequency. You may now file FCC Form 175 (along with engineering work from FCC Form 301 and another fee) to inform the Commission about your technical plans. The FCC has 30 days to accept this form, and another 30 days for public comment before accepting your Form “Accepted for Filing.” If you win the frequency auction, you must then submit a complete FCC Form 301, along with another filing fee. If approved by the FCC, you will be awarded a Construction Permit within 90 days. You are now about 92 weeks into the process, and have paid more than $9000 in engineering and application fees. But good news! You now have 36 months to build your radio station, including studios and production facilities, tower, antenna, and transmitter. If your ambitions are meager you might accomplish this for a million dollars or less, but more likely much more. The costs for maintaining and staffing your station will be in the tens to hundreds of thousands of dollars per year at minimum.

We could replace the word “radio” with “television” in the above paragraph, and multiply the cost factors by at least 10. Except you won’t find an available frequency in any area that’s actually populated, and if by some miracle you do you’ll be outbid by one of the dwindling number of large broadcast corporations. That, for the most part, is broadcasting in America, and it’s why radio and television have become increasingly irrelevant to the communities they ostensibly serve.
Which leads us to our first bullet-point worthy dictum:

- Media technologies and economies that require a corporate structure for functionality and viability will tend to empower the corporate structure.

In general, TV and radio broadcasting hasn’t worked for people and communities. The requirements of organization and capital raise the entrance barrier too high for all but a wealthy few. The few owners then must monetize the attention of their audience by selling your eyes and ears to advertisers. The flow of broadcast media is from them to you, and your job is to receive the message they send. Your only “choice” is to change the channel or turn off the receiver, thus disengaging from the medium. In essence, while you remain engaged, you work for them.

**The Revolution Will Not Be Televised (Scott-Heron, 1970)**

Just a century ago most Americans celebrated their arts and cultural heritage by actively participating in them. Before we had access to mass-produced news and entertainment, we made our own. People told family stories and shared what news they had, made more dear by its scarcity. Families made music together, and the influx of musical traditions and instruments fueled an American folk music culture that lead to Jazz, Blues, and their offspring. “Everyone was encouraged to take part, both men and women, from practiced musicians to visitors and children, and in the nineteenth-century home the quality might at times be excellent,” writes music historian Tim Brookes. “Yet in a sense that was not the point…it was an active, participatory tradition as opposed to the passive listening to radio and recordings.”(Brookes, 2005)

Henry Jenkins denotes a moment when the new mass media made possible by broadcasting quite naturally tapped the deep roots of American folk culture:

Initially, the emerging entertainment industry made its peace with folk practices, seeing the availability of grassroots singers and musicians as a potential talent pool, incorporating community sing-a-longs into film exhibition practices, and broadcasting amateur-hour talent competitions. The new industrialized arts required huge investments and thus demanded a mass audience. The commercial entertainment industry set standards of technical perfection and professional accomplishment few grassroots performers could match. The commercial industries developed powerful infrastructures that ensured that their messages reached everyone in America who wasn’t living under a rock. Increasingly, the commercial culture generated the stories, images, and sounds that mattered most to the public.(Jenkins, 2006)

We are now in a moment when grassroots production of cultural products reemerges as a realistic possibility for individuals and communities. The cost of producing high-quality media (text, image, audio, video) has dropped to about the price of a laptop. The cost of distributing that media content online, for those with access to an Internet connection, is
The rapid growth in the numbers of people producing digital media for online distribution, and the numbers of people looking to experience it, testifies to the value we derive in producing media for purely personal reasons. There may be no profit in this activity. It is true that one person’s blog may never reach more than a few dozen other people. But in the long tradition of folk culture, profit and reaching a mass audience were never the point. We have seen examples of “one person’s blog” having a profound impact on other people, communities, and perhaps the outcome of a presidential election.(Eberhart, 2005) But regardless of the reach of today’s “new media,” its impact and value can never be measured by Neilson or Arbitron ratings. If we want to make media more useful for human and community purposes, we must not deceive ourselves into thinking the mass media model developed in the 20th century is the only valid model.

We find ourselves, then, in transition between a “culture of mass media” where the technologies and cultural products are controlled by a handful of powerful corporate elites, to a time when almost anything goes. “The story of American arts in the twenty-first century might be told in terms of the public reemergence of grassroots creativity,” says Jenkins, “as everyday people take advantage of new technologies that enable them to archive, annotate, appropriate, and recirculate media content.”(Jenkins, 2006) Predictably, this scares the bejesus out of corporate media elites, who jealously guard their assets under the guise of copyright and intellectual property law. Never mind that almost all mass media assets are drawn from the same well as our centuries-old folk traditions. The act of borrowing from the songs and stories of other cultures is as old as culture itself. But in the current phase-transition, storytelling itself is a contested act. Which leads to our second big bullet-point:

• Participatory culture is not new, it’s just that we’re no longer used to it.

Is it any great surprise that at a time when folk practices are in digital renaissance, many of the same “commercial” mass media stories, images, and sounds are being reclaimed and remade on YouTube, Boing Boing, Ourmedia.org, and blogs everywhere? The content currency of the emerging online media commons highlights the power and cultural resonance of twentieth century mass media industries, but there is a fundamental difference: we are reclaiming our own voices, and making the stories our own.

From the perspective of an elite mass media corporation, this is bad enough. Add to this the rapid shift from “watching television” in the linear sense to the increasing consumption of media “on demand,” which undermines just about everything sacred about mass media economics. Market leaders can no longer rely on their traditional methods of reaching target demographics. Especially in the coveted 18-to-26 age bracket, “consumers are increasingly relying on search, recommendations from friends, and blogs to surface content,” says PBS’s John Boland. “To an increasing degree, consumers control the creation, distribution, and marketing of content.”(Borland, 2007)

But it this enough to satisfy those of us who self-identify as open content radicals? In my view, technologies don’t determine how they are inevitably used.(Nardi & O'Day, 1999) The emergence of ubiquitous media doesn’t guarantee equal access to authorship and
distribution. But the “network of networks” structure of the Internet provides the first realistic opportunity to disrupt the “one-to-many” media model that has so thoroughly consolidated control of media in the interests of political and economic elites in the 20th century.

So, another bullet-point:

- Media that can be mastered and managed by the individual will tend to empower the individual.

To the extent that we once bought into the idea of “Media with a capital M” as master of the market, ultimately what I’m suggesting is a redefinition of media. It’s personal now. It no longer does what it did in the fading broadcast era, and we have a chance to make it what it used to be: a communications channel between people for any purpose they imagine.

The Rise of Ubiquitous Folk Media

My station runs a community project called the Youth Media Workshop. We train kids aged 12 to 18 how to capture and edit digital audio and video, how to do interviews and research, and how to tell stories. In many cases they have amazing stories of their own, but they thought they didn’t have permission to tell them. We try to disabuse them of that notion. The results are often startling: kids headed for trouble turn into Honor Roll students, discover they have a voice, and begin dreaming about lives and careers they never thought they could imagine. Storytelling has always held great power to stir the souls of listeners and tellers alike. To see the transformations in these young students is to lose one’s cherished cynicism.

From this we have learned much about how participation in media can be encouraged and facilitated. It will take great effort to overcome the habits of thought encouraged by the dynamics of the previous mass media era. We must deliberately train and encourage our students (and ourselves) to be participants and creators of “folk media with a global reach.” As media creators, we are no longer beaming knowledge (or commercial messages) down from on high, but acting as participants in a continuing conversation about knowledge and community.

We are entering an era when the power to tell stories and make art is augmented by ubiquitous digital media, networked globally by the Internet. This is not a trivial observation. In his treatise on the innovators of personal computing, Howard Rheingold observes: “Less than a century after the invention of moveable type, the literate community in Europe had grown from a privileged minority to a substantial portion of the population. People’s lives changed radically and rapidly, not because of printing machinery, but because of what that invention made it possible for people to know.” (Rheingold, 1985) Networked digital media, connected by the Internet and fueled by a resurgence of personal creativity with great production tools, can do more than make
it “possible for people to know.” It can make it possible for them to speak, sing, draw, paint, and share their stories and vision with other people anywhere. This is what I mean now by the word media, and it’s quickly becoming ubiquitous.

**What does Ubiquitous Media have to do with Ubiquitous Knowledge?...or why EndNote is only a beginning**

Many people in academia are familiar with software such as EndNote, which allows the user to store references to books, journals, and other media objects. You can use the software to record metadata about these media objects (title, year, author, publisher, URL, etc.) in a variety of standard formats, and nonstandard information such as your own keywords and abstracts. You can then easily search your collection based on any of this metadata and filter the results. EndNote also facilitates the expression of your metadata in a growing number of standardized formats, such as the APA style of chapter notes used in this book. It can also export XML documents, which can then be transformed into any other text format and manipulated by other software for whatever purpose. It can even create web pages to display a set of records, or your entire reference library if you chose. So what you have with EndNote is a tool for adding meaning to media, and for retrieving, expressing and sharing that meaning with other people. As a bonus, it also makes creating chapter notes a snap.

Libraries, journals, and collections managers are working furiously to facilitate ingestion of information about their content into EndNote. There’s also an EndNote Web service where users can store individual collections online and access it from anywhere. All this allows the user to cultivate a personal information ecology drawing from global information resources to create a private reference library…or more precisely, a private library of references.

At another point of the ubiquitous knowledge spectrum, we have social bookmark tools like del.icio.us which enable users to store URLs with annotations and keywords. Since the annotations and keywords are part of the networked “public record” in relation to that URL, they help other people find online content relevant to any particular interest or search. Because user-generated keywords (“folksonomies”) aren’t participants in any kind of controlled vocabulary, they may at times add noise to the signal. But it seems that the relevance curve increases with the number of people tagging a particular resource, and the value of folksonomy has become well-accepted among respectable information architects. (Morville & Rosenfeld, 2006)

Among other examples of information environments which “harness collective intelligence” (O’Reilly, 2005): Flickr, JotSpot, Google Video, Backpack, Digg, Ourmedia, and the poster child for The Web 2.0, Wikipedia. Some of these sites are more or less commercial and proprietary (which could be a problem down the road if they are firewalled or go dark). In large part, search index them all continuously. But increasingly, rich media and knowledge resources are findable via the meanings and perspectives.
contributed by the people who use them. (Morville, 2005) These are examples of drawing from personal information ecologies and practices to create a global library of references.

When personal and global reference systems become fully interoperative, things could get interesting. In Rainbow’s End, computer scientist and novelist Vernor Vinge envisions a world in which access to all online knowledge is continuously available via wearable devices and ubiquitous computing. (Vinge, 2006) We don’t have to sign up for Vinge’s concept of a technological singularity (Vinge, 1993) to notice that ubicomp and continuously-connected online multimedia devices are becoming commonplace. So what does this mean for the idea and the reality of ubiquitous knowledge? Or perhaps a more useful question is, as educators what can we do about it?

A Modest New Media Manifesto

- Learn about and participate in new media
- Teach how to participate, including technology, analytic, and narrative skills
- Use the emerging global information commons to research, write, create, tell stories, publish, share, archive, and preserve content and metadata
- Develop useful personal information ecologies and connect them with the global
- Use, teach about, and advocate for open standards and non-proprietary tools
- Keep access to the Internet as open and public as possible

Much more needs to be said about challenges to open access: intellectual property law, government and corporate censorship, and proprietary systems and formats. But we won’t muster the determination to address these challenges unless we can imagine and articulate a vision of what ubiquitous media could mean for human knowledge, culture, and commerce.

Those of us who grew up immersed in the broadcasting era, we're cynical about changes in media. We've seen changes: from AM radio to FM radio to television to Cable and Satellite TV and now to HDTV and digital broadcasting such as it is. Despite changes in broadcast technology, the model has remained the same: people serving the interests of media. This makes us inclined to be slightly too skeptical to fully appreciate the opportunities before us. But we have to stop looking in the rear-view mirror and get busy. This time it’s about media serving the interests of people. So here’s perhaps the most radical proposition of all: To access ubiquitous knowledge, share your own.

Readings and References

Two scholarly books stand in stark contrast as regards the state of media, yet somehow encapsulate my argument: Robert W. McChesney’s outstanding history of U.S. broadcasting Telecommunications, Mass Media, and Democracy (McChesney, 1993), and Henry Jenkins’ Convergence Culture: Where Old Media and New Media Collide (Jenkins, 2006). Whereas McChesney’s view is that corporate dominance dooms media for purposes of community and democracy unless and until it is overthrown, Jenkins
argues that corporate media is increasingly irrelevant, and is being expropriated by the peasants regardless of what the tsar wants. Jenkins gives a nod to McChesney in his book while not backing down in the slightest, and they are both all the more relevant for the dialectic. Others weighing in on the subject: Don Tapscott and Anthony Williams in *Wikinomics: How Mass Collaboration Changes Everything* (Tapscott & Williams, 2006), the title of which is mostly self-explanatory but still a worthy read; Howard Rheingold in *Smart Mobs: The Next Social Revolution* (Rheingold, 2002), which waxes (perhaps a bit too) enthusiastic about spontaneous social organization via instant-access technology; Howard Rheingold again with *Tools for Thought: The History and Future of Mind-Expanding Technology* (Rheingold, 1985), a brilliant book about brilliant people who somehow invented personal computers and network technology; David Weinberger in *Small Pieces Loosely Joined: A Unified Theory of the Web* (Weinberger, 2002) and in the marvelous, well, manifesto entitled *The Cluetrain Manifesto: The End of Business as Usual* (Weinberger, Levine, Locke, & Searls, 2000); and speaking of manifestos how about McKenzie Wark’s *A Hacker Manifesto* (Wark, 2004), which cries out to be hacked by more of us; and a book that saw lots of this new media stuff coming even before the web, Stewart Brand in *The Media Lab: Inventing the Future at MIT* (Brand, 1987); Bonnie Nardi and Vicki O’Day, who remind us in *Information Ecologies: Using Technology with Heart* (Nardi & O’Day, 1999) that nothing is inevitable about how we choose to use things, so why not make choices that serve our interests (and oh, by the way, what are they?); Richard Adler with a deep look at how the “media industry” is shaking in its boots about new media in *Next-Generation Media: The Global Shift* (Adler, 2007); and for a practical look at what to actually know and do to make knowledge “findable,” Peter Morville’s plucky little book *Ambient Findability* (Morville, 2005), which we should all find, along with *Information Architecture for the World Wide Web* (Morville & Rosenfeld, 2006) for those who want to get totally geeked. When it comes to architecting ubiquitous knowledge, searchability is good but findability is even better…


Robinson, J. (April 15, 2007). BBC to put one million hours of its past online. The Observer, from http://observer.guardian.co.uk/uk_news/story/0,,2057465,00.html
Chapter 8: Ubiquitous Learning: Educating Generation ‘I’

Evangeline S. Pianfetti

Understanding Ubiquity and Generation ‘I’:

Technology has the power to inspire us to transform the way we live, the way we teach, and the way we learn. It is the impact of technology on every facet of our lives, known or unknown that defines its ubiquity. And yet, as we look at the majority of classrooms, the way we teach and the way we learn have not changed over the past several hundred years. There are still basic principles and tenets that are followed which define a standard for what it means to be educated. For example, teachers still aim to ensure that children can read, write, and conduct basic mathematical operations. We see that in the majority of classrooms students need to interact with others, students need to learn certain facts and skills, and students need to receive feedback and assessments on their learning. Our challenge as educators is how we balance out these basic principles for a generation that has grown up immersed in technology and for whom the expectations of the workforce have changed. We have spent so much time trying to close the achievement gap and making sure that “no child is left behind”, that we may be failing in understanding what our students need to thrive in a 21st Century society. Wallis et. al (2006) identifies characteristics that will define our future workforce. These include having individuals who can think across disciplines and whose quest for learning allows them to construct their own knowledge path while teachers facilitate their experiences. They will use new approaches to solve problems in ways not previously possible. These individuals think creatively and rapidly process information. Schools need to shift their focus to ensure that students not only gain core knowledge, but also possess portable skills that will allow them to command the workforce. And for no group is this more critical, than Generation ‘I’. Generation ‘I’ is just starting to enter elementary school and these students do not know a time the Internet did not exist or that certain technologies such as smart phones, digital cameras, blogs, and wikis were not always a part of mainstream society. As educators, we will soon collectively be facing these students whose expectations for teaching and learning are in part defined by the ubiquitous access to technologies that they so readily employ in their daily lives. Gardner (1983) established an idea that the varying nature of learners means that teachers should employ differentiated points of instruction into their curriculum. Today, as we explore the kinds of learners that are found in the classroom, one attribute crosses all learning styles for Generation ‘I’. These students are digital learners because of the ubiquity of technology that surrounds them.

Consider this: it is estimated that the average student from Generation I will graduate college having played over 10,000 hours of video games (Interactive Videogames, 1996), having spent over 10,000 hours talking on cellphones and watching about 20,000 hours of television (Prensky, 2001). In 2004, the Institute for Social Research suggested that children and teenagers will spend at least 2.75 hours a week using a home computer and projected that this would increase as the cost and efficiencies offered by personal computer became more accessible to the average family. We see that an estimated 70%
of children between the ages of 4 – 6 have used a computer (Kaiser Family Foundation, 2003). The statistics are steadily increasing. Technological devices are defining how students remember, understand, apply, analyze, evaluate, and create their own knowledge path (Anderson & Krathwohl, 2001). And the vital force of these technological devices is their ubiquity. For Generation “I”, their “www” – is wherever, whenever, and whatever (Teachertube.com). Ubiquitous learning through the integration of technology allows for reflection, questioning through inquiry-based practices, meaningful learning through context-rich instructional environments, and problem solving in which students engage in critical thinking. The Generation ‘I’ Classroom will be defined by paperless homework, school to home portals, ebooks, online learning and ubiquitous access to resources. For Generation “I”, iPods, wiki, blogs, Facebook, MySpace will be common tools for learning. But, as stated by some preservice teacher educators working collaboratively to define their vision for technology in one of the introduction to technology courses in the College of Education at the University of Illinios, Urbana-Champaign, “the “I” cannot be limited to a list of devices produced by major corporations, but rather the idea extends to a shift in the way we connect with the world. And in no place is the need to incorporate these trends more appropriately than in the classroom.” And yet, 90% of schools have Internet access, but only 20% of teachers feel prepared to use it for instructional practices or to engage students in learning. For this reason, it is imperative that educators participate in professional development activities that will empower them to transform the way they teach so that their students become life long ubiquitous learners. It is the ubiquity found in our access to a variety of educational technologies that will propel our students beyond their expectations. The technological momentum that will come with students from Generation ‘I’ will bring with it sweeping change in the classroom. The efforts of those who have been the early adopters of technology in their classrooms will soon be the models by which coming revolution in the classroom will be based. We are at a tipping point in the training of tomorrow’s teachers, the skills we impart in them now will define the failure or success of Generation I students.

The TIMeS Project: A Technology-Intensive Mathematics and Science Model for Improving Instruction in High Needs Schools

For over three years, the Office of Educational Technology (OET) and Office for Mathematics, Science, and Technology Education (MSTE) from the College of Education and instructors from the departments of mathematics and physics in the College of Liberal Arts and Sciences all from the University of Illinois at Urbana Champaign have implement a statewide professional development project with several Illinois school districts as part of the Technology-Intensive Mathematics and Science (TIMeS) project. This project was designed to increase teacher content-area knowledge in math, science and literacy through the use of technology and, with the goal to improve student achievement in those areas. The TIMeS project targets schools that have ISAT scores that demonstrate a need for improved student achievement in mathematics, literacy, and/or science and have teachers with provisional certificates or who are teaching out of their area in math or science. Although everyone recognizes the link between math and science, many people do not seem to realize that literacy, the ability to
read and write, is a critical pre-condition for success in both those fields. Many math teachers can trace their students' difficulties back to difficulties in reading math problems. By the same token, although many people recall science textbooks as dense and full of challenging vocabulary that can make comprehension difficult, fewer recognize the unique challenges presented by scientific writing. One way to improve student learning is to utilize cross-curricular lessons and inquiry learning, which attempt to situate new concepts in concrete situations that are relevant to the students. This way, all three foundational subjects can be strengthened at the same time. Hence, the TIMeS Project provides standards-based professional development opportunities for teachers, who are teaching out of their trained content area or have provisional certification. These intensive professional development opportunities are designed to support efforts in which educators in "high need" schools engage their students with technology-rich lesson plans that provide an authentic context for concepts taught within mathematics, science and literacy. The application of these technologies emphasizes the opportunities that come with the emerging technological society and provides a high comfort level with technology as well as fundamentals for their application that will enable these teachers to maintain their “ubiquity of knowledge” as the technologies they incorporate today change in the future.

The TIMeS Model has six major components:

I. **Participant Training**: The TIMeS model has two training cohorts, one face-to-face (grades K-2 teachers) and one on-line (to accommodate the teachers in grades K-8).

II. **Access to Technology**: Teachers are not able to effectively integrate technology unless they have the hardware and software on which they are trained. The TIMeS Model provides technology to all the participants to use in the classroom.

III. **Classroom Implementation**: Each of the cohorts of teachers is required to implement their new knowledge/skills in their classrooms.

IV. **Sustained support**: Participant teachers have access to the TIMeS staff and equipment for help in planning, implementation or troubleshooting. The support is scaffold support through which the TIMeS staff works with participating teachers so that they subsequently become their own layered support for their school.

V. **Evaluation/Reflection/Collaboration**: Teachers are asked to participate in an online discussion board about their successes and failures with attempts to effectively integrate technology.

VI. **Pre-service Connection**: Student teachers at the UIUC College of Education have access to TIMeS staff, training and equipment.

There are clear indications that these elements are instrumental in enabling educators to transform their instructional practices from a teacher-centric model to a teacher as facilitator model where inquiry based learning through ubiquitous access to technical resources is the capstone of the classroom. One of the most significant changes in the structure of learning tasks took place in a 4th grade classroom where no one wanted to
Students hated writing; their writing assignments reflected that (including those with good writing skills) and the teacher hated correcting them because they were so fraught with errors and basic lack of effort. As a participant of the TIMeS project, this fourth grade teacher decided to redesign the assignment to include digital images and video to help assist with writing. For example, in four square writing, the writing technique used in the district, the students write an introductory paragraph, three supporting detail paragraphs, and a conclusion paragraph. In teaching her students to write the steps in a process, this teacher had students take cameras home and film the things that they did during the morning, afternoon and evening every day. This activity could be used prior to writing to help students visually organize the steps in a day and then write the paper to go with the images, or to illustrate the paper they have already written. The student products improved significantly. For example, students illustrated the scientific method by photographing each step of an experiment in which they practiced the scientific method. The students were given several experiments from which to choose. The experiments illustrated concepts that would be covered in the science curriculum during the year. In PowerPoint, slides were created that explained the experiment in terms of the scientific method. Digital images were embedded in the PowerPoint slides where images assisted with the explanation of the scientific process. Students then shared the presentations exposing all the students to several examples of the real-life application of the scientific method.

Another indication that teachers were transforming their pedagogy could be seen in a classroom where graphing calculators and small robots were used to make order of operations an inquiry-based lesson. Students were given a series of math sentences that had no parentheses and were asked to solve them based on their guess about how the steps should be sequenced. The answers were entered into a program in the small robot. If their answers were correct, the robot would follow the path that was laid out by the teacher. Wrong turns indicated wrong answers. After making corrections so the robot would follow the correct path, students were able to contribute to an introductory discussion of the order of operations.

Webquests were also a strong component of the TIMeS model that allowed teachers who traditionally did not use inquiry as a support for learning to slowly develop projects that encouraged learning surrounding an essential question. In many cases, the teachers motivated student learning by creatively designing a Webquest that pushed their students to think in multiple dimensions. One Webquest that is indicative of best practice is: Travel Illinois, a fourth grade webquest designed by a TIMeS teacher [http://localweb.tuscola.k12.il.us/breifsteck/reifweb/illinoiswebquest/process.htm](http://localweb.tuscola.k12.il.us/breifsteck/reifweb/illinoiswebquest/process.htm). This teacher included the use of a Webquest as a means to provide cross-disciplinary opportunities to learn about history, geography, visual arts and technology.

In the end, the TIMeS model allowed teachers the freedom to try without fear of failure. When success was obvious, pedagogy coupled with technology becomes an integral part of instructional practices, student work, and assessment. The changes in pedagogies exhibited by TIMeS teachers are well suited for educating Generation I. Generation I students require that their learning be closely aligned with future workforce expectations.
This includes the ability for them to collaborate with others to solve problems such as the experience they gain working on Webquests, and the ability to cross disciplines with their ideas and efforts such as the experience they gained working with digital media. The use of technology to denote missteps in thinking as indicated by the graphing calculator and robots example is also a critical skill needed for Generation I learners. Unlike other generations that may use technology as a means to come to an answer, Generation I will use technology as a vehicle through which they come to discover a solution or question the validity of an answer. Without employing such pedagogies as inquiry-based instruction or project-based learning, teachers will not reach Generation I students at the level which will make them prosper in mind and in the workforce.

Towards an Agenda for Ubiquitous Learning

Technological resources are helping to define a generation for whom the pursuit of knowledge is framed by their own construction of meaning and understanding. For Generation ‘I’, the pursuit of learning comes by asking critical questions and establishing the means by which knowledge is gained through authentic learning activities. As educators, it is imperative for us to engage students at their level. This includes designing educational environments that integrate technology through authentic learning tasks. Learning should be framed by critical thinking through the solving of real life problems. As educators, we need to start looking at the ubiquity of technology that is defining our society and translating the “common uses” of technology into meaningful learning experiences. This means we need to not shun the use of technological resources such as cell phones or gaming in the classroom, but embrace them for the new dimensions and perspectives to learning that their users bring. We need to start redefining the common notions of literacy to include the digital learner. Consider that by today’s standards, the average student graduating college has read and responded to over 200,000 emails since they first used email as a communication tool, some as early as middle school. How will this make us rethink literacy and how we approach the fundamentals of reading and writing in the digital age? We need to map a research agenda in which we articulate both the promises and the challenges that will redefine what it means to be educated as a member of Generation I. We cannot risk robbing our children of the potential that is found in each of them because we do not rethink what it means to teach and to learn within the Age of Information. As educators, we need to be agents of change by establishing and/or participating in sustained professional development activities, developing quality digital content from which our students learn such as from podcasts, and webquests, and we need to collaborate and network with each other so that we garner strength through our content and technical expertise. In the end, as educators we need to be able to provide students not only with the tools and skills they need to succeed, but also with the belief that their ideas can inspire innovation and creativity in our society. This will be the lasting legacy of Generation “I” – ideas, inspiration, and innovation.

Readings and References
For those wanting to learn more about the intersection between education, technology and professional development, the best sources are to read a survey of ideas articulated by some key leaders in the field. Recommended sites for these readings include:

- Will Richardson - http://weblogg-ed.com/
- Tim Wilson - http://technosavvy.org/ (he spoke at the ICE conference)
- Stephen Downes - http://www.downes.ca/
- Sheryl Nussbaum-Beach - http://21stcenturylearning.typepad.com/blog/
- James Farmer - http://incsub.org/blog
- David Warlick - http://davidwarlick.com/2cents
- Alan Levine - http://cogdogblog.com/
- Vicki Davis - http://coolcatteacher.blogspot.com/
- Scott McLeod - http://www.dangerouslyirrelevant.org/
- Edutopia: http://www.edutopia.org/professionaldevelopment/


TeacherTube (2007).

Chapter 9: The Implications of Digital Ubiquity for Defining Youth and Adult Roles within Learning Environments

Lisa M. Bouillion

Today’s youth have grown up in a world infused with digital technologies: video games, cell phones, digital music players, and computers. Despite continued reports of technology access and literacy divides among adults, ninety percent of children between the ages of 5 and 17 now use the computer in either home, school or community contexts (Fox, Brooke & Snyder, 2005; US Department of Commerce, 2002, 2004). Further, 84% of teenagers report owning at least one personal media device – a desktop or laptop computer, a cell phone, or a Personal Digital Assistant (PDA) – and 44% say they have two or more devices (Lenhart, Madden & Hitlin, 2005).

In contrast to youth who have grown up with digital ubiquity, today’s adults are regularly translating prior practices to fit within this new world. Mark Prensky (2001) argues that this translation often reflects an “accent” that marks adults as “digital immigrants”. As examples of this accent, he cites practices such as turning to the Internet for information second rather than first, printing emails, editing documents first on paper and then on screen, and turning to a software manual rather than assuming that the program itself will teach us to use it.

For those of us committed to goals of youth development, it is critical to better understand the implications of digital ubiquity for the design of engaging and meaningful learning environments. The National 4-H program is presented here as a case study of how tech-savvy youth or “digital natives” (Prensky, 2001) can be tapped as a valuable resource to address community-based issues and concerns. This case will be used to consider related learning opportunities and design questions. A key assumption that will be elaborated is that digital ubiquity has contributed to a blurring of the border between youth and adult worlds of practice, thereby challenging us to re-think traditional youth and adult roles within learning environments.

4-H Youth Development: Community Mapping with Geospatial Technologies

Founded in 1902, 4-H is a youth development program currently serving over 6.5 million youth in the United States. This program is delivered through the Cooperative State Research, Education, and Extension Service (CSREES) connecting land-grant universities across the 50 states. 4-H clubs are facilitated by adult volunteers and provide a supportive out-of-school context in which youth have an opportunity to explore a wide range of topics through experiential-based projects (e.g. cooking, small machines, animal science, photography). This range of non-formal learning opportunities has recently
expanded through a national 4-H mission mandate to engage 1 million new young people in the exploration of science, engineering and technology.

Community mapping with geospatial technologies is one of several new 4-H curriculum offerings using technology to intentionally support youth development by positioning youth as a resource within their communities. 4-H youth around the country are using global positioning system (GPS) devices, handheld computers, digital cameras and other mobile technologies to collect data about their communities. Through a partnership with ESRI, a world leader in GIS (geographic information system) modeling and mapping software, nearly 400 4-H clubs have received grants to support these efforts and are using the latest commercial software to map and analyze their locally collected datasets.

In Monroe County, for example, University of Illinois Extension 4-Hers have collaborated with the Stemler Cave Woods Nature Preserve, Monroe County Farm Bureau, Monroe County Soil and Water Conservation District, and Illinois Conservation Officers to create maps of local green spaces, bike paths, hiking trails and other conversation resources in the community. Youth in the Barnstormer 4-H club of Monroe County live near the Stemler Cave Woods Nature Preserve. They regularly help to maintain the preserve walking trails as well as develop informational materials for use with visitors. Using GPS and GIS technology, club members developed the map shown in Figure 1 for use in an information brochure to better mark the locations of the interpretive signs that can be found along the trail.

Figure 1: Nature Preserve Map Created by Monroe County, Illinois Barnstormers 4-H Club

Reflecting a diversity of neighborhood needs and partnership opportunities, other 4-H youth mapping projects have collected data on things such as the location of after-school programs, vacant lots, sites of illegal trash dumping, fire hydrants and other water sources, emergency evacuation sites, cell towers and signal strength, public computer access points, and historical landmarks. These data are collected and shared in partnership with a range of adults representing schools, city councils, departments of
housing and social services, chambers of commerce, libraries, police and fire departments, hospitals and local businesses.

**Education, Play or Work?: Digital Ubiquity Bridging Worlds of Practice**

Many youth are introduced to geospatial technologies through the increasingly popular sport of “geocaching”. Using handheld GPS (global positioning system) devices as a digital map, the goal of the sport is to follow a series of longitude and latitude coordinates (i.e. waypoints) to find your way to a hidden treasure or “cache”. GPS technology continues to proliferate worldwide and can be found in everything from cars and airplanes to cell phones and wristwatches. While geocaching is frequently pursued for entertainment purposes, the digital ubiquity of handheld technologies creates an opportunity for connecting youth to a wide range of adult communities in which GPS is used for commercial purposes, such as farming, construction, transportation, public safety, mining, city planning and conservation. GIS technology (geographic information systems) is similarly ubiquitous; most visible to the everyday user through online, interactive map programs such as Google Maps and MapQuest.

While organizations increasingly see the value of geospatial technologies, many do not have the internal resources required to leverage it. Within the context of 4-H clubs, youths’ familiarity with geospatial technologies is used to engage them in exploring and identifying points of interest in their communities that can be shared with a range of audiences. Youth members pledge, “My Head to clearer thinking, my Heart to greater loyalty, my Hands to larger service, and my Health to better living, For my club, my community, my country, and my world.” A view of youth as a valued resource in communities is central to the 4-H program design. From this basic assumption, it is an easy transition to expecting that youth have much to offer adults in terms of leveraging digital ubiquity to meet diverse needs.

**Re-Defining Expertise within Digital Ubiquity**

The case of 4-H Community Mapping makes evident the ways in which the ubiquity of digital technologies is contributing to a blurring of youth and adult communities of practice (Lave & Wenger, 1991). The model of “youth as learner” and “adult as teacher” no longer fits within this framework. Here we find it helpful to distinguish between at least three dimensions of expertise or knowledge that are brought together within these youth-adult partnerships: 1) tool expertise, 2) content expertise, and 3) context expertise. Take for instance the example of a project in which youth are mapping emergency evacuation sites. Youth may bring knowledge of how to use handheld technologies for data collection (e.g. digital cameras, GPS device, etc.), while an adult partner may bring tool expertise related to GIS software used to visualize the data. An adult partner may contribute content knowledge regarding the criteria that defines a suitable emergency evacuation site, while youth bring knowledge of their community context. The mix of
contributed knowledge varies from project to project, but in each case the roles of teacher and learner are fluid across youth and adult participants.

This fluidity of roles is further shaped by the affordance of handheld technologies to create portable, socially interactive, context sensitive and individualized learning experiences (Klopfer, 2002). In the context of community mapping projects, youth move with these technologies from their club meeting, to the streets of their city, to the workplace of partner organizations. Across these varied contexts, the value of the technology may shift from building community ties to investigating new data to presenting findings to an external audience. Just as the line between youth and adult worlds are increasingly blurred, so are the lines between when we are playing, working and learning. While less has been done to explore this intersection in relation to handheld or mobile technologies, a parallel can be found in the emerging body of research around video games that identifies motivational opportunities for youth engagement (Lenhart, Madden & Hitlin, 2005; Levin & Arafah, 2002), learning opportunities to support and develop new literacy skills (Gee, 2003), and developmental opportunities to support identity formation and self understanding (Turkle, 1984, 1999; Bers, 2001).

A Call to Articulate Principles of Mutuality within the Design of Learning Environments

The central proposition of this chapter is that digital ubiquity calls upon us, as educators and designers, to better understand how to facilitate mutuality among youth and adults within learning environments. Mutual, in this case, describes a relationship of reciprocal dependence, action, or influence in which there is shared contribution and shared gain. As Fielding (2001) describes, “the accepted roles of student and teacher become less mutually exclusive, more open to extension and reversal, more open to mutual learning, more welcoming of a radical collegiality” (p. 108).

The concept of mutuality is not new to education and can be found within research that connects positive youth outcomes to relationships with caring adults (Benson, Leffert, Scales, & Blyth, 1998; Eccles & Gootman, 2002; Grossman & Johnson, 1999; Jekielek, Moore, Hair, & Scarupa, 2002; Hererra, Sipe, McClanahan, Arbreton, & Pepper, 2000; Paisley & Ferrari, 2005; Peterson et. al., 2001; Pittman, 1992; 2001; Scales & Gibbons, 1996; Sipe, 2000) and attributes improved student and school outcomes to program structures for student voice (Costello, Toles, Spielberger, & Wynn, 2000; Fielding, 2001,2004; McLaughlin, 1999; Mitra, 2004; Takanishi, 1993).

Classrooms and programs that seek to connect learning experiences for youth to the practices of adult communities often claim a goal for “real world” or authentic learning. The curricular models loosely categorized under this umbrella reflect varied design approaches, including project-based or problem-based learning (e.g. Hmelo, Gotterer & Bransford, 1997), anchored instruction (e.g. Cognition and Technology Group, 1990), workplace apprenticeships (e.g. Fuller et. al., 2005; Hamilton, 1990) and service learning (e.g. Youniss & Yates, 1997). Many of these curricular designs trace their inspiration to
work by John Dewey (1938) and other situative learning theorists (e.g. Vygotsky, 1978; Brown, Collins & DuGuid, 1989) who argue the importance of context, discourse, community tools and social interaction as scaffolds for learning. The rhetoric of real world learning is a prominent theme within educational reform (Petraglia, 1998), yet the assumptions about what we recognize as real world learning and how we expect to support those learning experiences remain undertheorized (Radinsky et. al., 1999).

“Third space” research - across anthropology, education, psychology, and human-computer – offers a promising framework through which to advance our understanding the measure of mutuality within learning environments that seek to connect youth and adult communities of practice. Defined as the overlapping space of two communities, “third space” is characterized by its hybridity and reflection of attributes from each community that come together in often unexpected ways (Bhaba, 1994). The attributes of activity within this space – such as de-centered authority, ill-defined tasks, diverse perspectives, and a need for negotiation and dialogue to bridge differences – are connected to opportunities for mutuality within learning environments (Bouillion & Gomez, 2001; Gutierrez, Baquedano-Lopez, & Alvarez, 1999; Moje et. al., 2004) as well as work environments, such as the intersect of software designers and end users (Muller, 2003). As diverse literatures are considered together, it is interesting to note the similarity between characterizations of “third spaces” and characterizations of authentic learning activities which include ill-defined and complex tasks completed over a period of time, opportunities for collaboration, opportunities to examine tasks from different perspectives, and opportunities for reflection (Reeves, Herrington and Oliver, 2002).

While the framework of third space is useful in characterizing principles of mutuality, it leaves us with many questions about how to productively and successfully sustain activity between youth and adults within an overlapping space that is reflective of both communities and retains true hybridity. As previously outlined, the space of hybridity is characterized as unpredictable, ill-defined and potentially contentious. Many “real world” constraints have the potential to shape youth-adult collaborations in ways that privilege or reflect one community of practice over the other, making it difficult to achieve youth-adult partnerships of mutual benefit (Bouillion & Gomez, 2001; Radinsky et. al., 1999). For instance, when the adult(s) is involved primarily for altruistic reasons and has limited stake in the content or product outcome, the activity is more likely to reflect and be shaped by youth interests, knowledge and practices. While youth engagement and ownership are potential gains in this scenario, they come with the potential tradeoff in lack of rigorous content and/or application of that content to adult worlds of practice. On the other hand, youth-adult activities may privilege adult expectations and experience, particularly when the adults have a high stakes investment in the content or product outcome (e.g. standardized test scores, a time-specific workplace need for the activity product, etc.). The potential gain is that youth develop a deeper understanding of content and practice related to the adult community. The tradeoff is the risk that youth will fail to see the relevance and meaning of this activity to their own lives.

The ubiquity of digital technologies in our society is chipping away at the borders of what we define as youth and adult practice, thereby challenging us to reconsider how we
define activities of education, play and work. While the value of these technologies is increasingly embraced by diverse communities of practice, adults often find themselves struggling to adapt prior practices within this new paradigm. Youth have little input into discussions around why and how technology should be used to support learning. These decisions are made by teachers and administrators who often have limited information on the practices and expectations of digital natives (Prensky, 2001). The risk is a growing disconnect between teachers and their more tech-savvy students (Levin & Arafeh, 2002; Tapscott, 1998). Left unattended, this disconnect is likely to impede opportunities for learning and contribute to a pattern of disengagement in which some learners fail to see formal and/or nonformal educational programs as an avenue for life progress (Barton, 2000; Ladson-Billings, 1995). The design challenge before us is to identify and create social arrangements that support mutuality in youth-adult interactions.

**Readings and References**


Chapter 10: Digital Divide and Access to Higher Education in Sub-Saharan Africa

Fazal Rizvi

The Commonwealth is a most curious of international organizations. It is a voluntary association of more than fifty independent sovereign states, most of which were once British colonies, but now hold strong postcolonial aspirations. These countries join together in lofty goals, which include the promotion of democracy, human rights and good governance, but have little wealth in common to pay for their ambitious plans. The interests of the richer Commonwealth countries seem to lie elsewhere, with the more influential international organizations such as the OECD, while its poorer members are relegated to the margins of the global political system. Yet the Commonwealth heads of government meet regularly, even if little is achieved at these meetings beyond pious rhetoric about the need for cooperation. It is difficult to point to any major achievements resulting from these meetings.

Perhaps a notable exception to this is in the area of education, where cooperation among Commonwealth countries has ranged from such programs as the Colombo Plan to its more recent initiatives in open learning and distance education. The Commonwealth has always viewed education as fundamental to social and economic development. This sentiment was reiterated by the Commonwealth Ministers of Education at their meeting in December 2006, held in Cape Town South Africa. Much of their discussion centered on globalization and the imperatives of the new informational economy, and the implications these had for educational policy and practice. Given its location, the meeting explored the potential of the new technologies for expanding access to education, particularly higher education, especially within the Sub-Saharan countries. Much of this debate centered on the idea of ‘digital divide’. Repeatedly, the ministers argued that the capacity to use information technology had become a fundamental tool of development, and that the issues of ‘digital divide’ were now inextricably linked to the global flows of information and communication.

In this chapter, I want to examine the idea of ‘digital divide’, as it has become commonly used in characterizing global inequalities, and discuss some of the suggestions made and initiatives taken for overcoming it. In particular, I want to consider the case of African Virtual University (AVU), sponsored initially by the World Bank but now supported by both the Commonwealth, and a range of other international organizations. AVU is designed to provide greater access to higher education in Sub-Saharan Africa, and is based on a number of assumptions. It regards online learning not only as an affordable, flexible and effective means of delivering higher education within the African context but also as a way of preparing Africans to participate in the global informational economy. It underlines the university’s potential for bridging the digital divide. I want to assess these claims, and argue that initiatives such as the African Virtual University are based on very
limited narrow views of both the idea of ‘digital divide’ and access to higher education, and risk reproducing and even extending the problems they seek to address.

Although the term ‘digital divide’ is little over ten years old, it has quickly become part of a new global slogan system -- so much so that it now masks more than it elucidates the nature of the stratifications between those who are and those who are not networked. However, it does point to something significant in the ways in which social and economic development has now become highly dependent on a country’s capacity to participate in the new informational economy. This new economy, as Manual Castells (2000), among others, has pointed out, is characterised largely by science and technology, a shift from material production to information processing, the emergence and expansion of new forms of networked industrial organizations and the rise of socio-economic globalization. Castells argues that economic productivity is now linked to the quality of information and its management in the processes of production, consumption, distribution and trade. This is so because there has been a shift from material production to information processing industries such as health care, banking, software, biotechnology, media and of course education, and because global trade now involves global circuits of knowledge exchange and data processing.

If the participation in these information-rich industries has become fundamental to economic development then the idea of ‘digital divide’ can be viewed as a major source of underdevelopment. But how? Given the complexity of ‘informationalism’, as Castells calls it, digital divide cannot simply refer to the uneven distribution of the technology hardware across communities. It is a much more complicated and multidimensional phenomenon that incorporates a whole range of factors, from access to computers to the manner in which knowledge is now produced and distributed. Pippa Norris (2001) has, for example, suggested that the idea of ‘digital divide’ refers to three distinct divides. First, global digital divide refers to the unequal Internet access between industrialized and developing societies. Second, social divide refers to the divide between information rich and poor in each nation. And finally, and more significantly, Norris introduces the idea of a democratic divide to signify the differences between those who do and do not use the enormous and growing resources of the Internet to engage, mobilize and participate in public life.

But even this corrective does not fully capture the complexities surrounding the idea of ‘digital divide’. With the size of online community doubling every year (van Dijk 2005), it is now clear that the Internet is transforming the way people live, work and play. Few now doubt that digital technologies are transforming the flow of capital, goods and services within the global marketplace. The Internet has not only become an important element of economic activity but also a ubiquitous source of information. The potential impact of the Internet on the developing countries is hard to assess. On the one hand, some argue that digital technologies provide developing countries opportunities to ‘leapfrog’ various stages of economic and social development, while others maintain that the information economy fundamentally favors the already information-rich societies. The voices of the developing countries on the Internet are almost entirely absent. As Ferguson (2005) notes, in the neo-liberal world order, Sub-Saharan Africa has been pushed further
into what he calls the ‘global shadows’, inextricably linked to the global economy yet in ways that marginalize its voices.

The Internet age thus has the potential to extend the disparities between the postindustrial economies at the core of the global economic system and developing societies at the periphery. The richer economies are able to use to digital technologies to boost productivity while the poorer societies are left in a position to play ‘catch up’, which they can seldom do due to the fast changing nature of the digital technologies. The Commonwealth ministers in Cape Town were fully aware that the always shifting nature of the new technologies had the potential to reinforce the patterns of stratification in the new economy. Indeed, the network society may be creating parallel communication systems: one for those with income, education and literally connectivity and the other for those without connection and plentiful information to thrive in the new economy. If this is so then the problem of the digital divide is linked to the structural exclusion of most Sub-Saharan nations from the knowledge economy where know-how and information replace land and capital as the basic drivers of economic growth and productivity. This suggests the need to understand digital divide in relational terms, rather than in terms of deficit -- of either equipment or skills.

The idea of ‘digital divide’ is often discussed as an issue of access to technology hardware and Internet connectivity, as well as know-how. Many of the initiatives in Sub-Saharan Africa to overcome the digital divide have centered on the provision of computers and connectivity. But this is a problem that can easily be resolved by higher levels of investment and the availability of inexpensive computers. The MIT Media Lab’s much-publicized $100 computer, now referred to as XO-1, will soon be a reality, as might the ways to solve the problems of broadband. But this will not close the digital divide, because even if everyone throughout the Sub-Saharan Africa were given a free computer, they might not be able to use it. There would remain the problem of literacy and technical skills required to access the information and services available on the Internet. As Warschauer (2003) argues, the discussions about the "digital divide" must now shift from gaps to be overcome by providing equipment to challenges facing the effective integration of technology into communities, institutions, and societies. What is most important, he suggests, is not so much the physical availability of computers and the Internet but rather people's ability to make use of those technologies to engage in meaningful social practices.

The Commonwealth ministers in Cape Town accepted this diagnosis, and reiterated the importance of higher education both in overcoming the digital divide and in taking advantage of the opportunities offered by the new technologies. Indeed, if the failure to access and utilize the new technology and information implied an even greater marginalization from the world economy then the developing nations, they agreed, had no other option than to invest in forms of higher education that were efficient and effective, and developed competencies and skills appropriate to the successful participation in the new knowledge economy. They thus viewed programs based on the new technologies favorably, as a way of meeting the fast-growing demand for higher education in Sub-Saharan Africa, especially in context of the inability of their
governments to allocate the resources that would be required to build and develop university campuses. They maintained that the new technologies had the potential to increase efficiency in the provision and quality of higher education through more flexible forms of delivery, and supported initiatives that used these technologies to ‘scale-up’ the delivery of online programs, so long as new policies were also developed to coordinate the accreditation, recognition and quality assurance of online programs, especially when these are offered across national borders.

An example of such an initiative to expand access to higher education to students throughout Sub-Saharan Africa, widely discussed at the Commonwealth meeting in Cape Town, is the African Virtual University (AVU). As described by Juma (2006), AVU was established in 1996 as a World Bank project, and was originally conceptualized as a technology-based distance education network to bridge the digital divide in Africa, especially by building capabilities in science, computer studies and engineering. It was designed partly to meet the fast growing demand for higher education in Africa, and was viewed as an alternative to the traditional and expensive to build and run ‘brick and mortar’ universities. AVU’s delivery model sought to make extensive use of satellite and Internet technologies, allowing it to offer online programs from around the world, while taking into account the infrastructural limitations prevailing in Africa. In this way, AVU did not feel compelled to develop its own distinctive programs but purchase instead content that was already developed elsewhere and offer it to students under license through a network of learning centers.

In the first phase of its operations (1997-1999), AVU offered short courses developed at institutions in the USA, Ireland and Canada, as well as the World Bank. During the second phase (1999-2002), it established thirty-one learning centers in seventeen African countries, which supported students to complete the learning requirements of the courses. During this period, AVU viewed its efforts in improving connectivity between the AVU learning centers, host African universities and the mostly western universities that had developed the content, as a way of bridging the digital divide (Juma 2006: 350). Because this training involved regional and global interconnectivity, AVU expected its programs to also serve as a catalyst for new investment and economic development in Sub-Saharan Africa. During the current phase (2002-2007), the number of learning centers has expanded significantly and AVU now offers degree programs in computer science and management, including two it has purchased from Royal Melbourne Institute of Technology (RMIT) and Curtin University of Technology in Australia. It now possesses its own Very Small Aperture Terminal (VSAT), a satellite communications system that handles data, voice and video signals.

In less than ten years, AVU can claim significant achievements. It has provided education to countless number of students; and its short courses in particular have built capacity for many people in different occupations. It has managed to develop an impressive array of partnerships with overseas universities and institutions including Africa America Institute, Australian Agency for International Development and Association of Canadian Universities and Colleges. It has encouraged, albeit to a very small degree, resource mobilization and sharing across the Sub-Saharan region. Arguably also it has generated
greater interest among academics throughout Africa in ICT-enhanced learning and in the ways technology might be used to improve the quality of teaching and learning than might otherwise have been the case. It can also claim to have encouraged greater participation of women in science and engineering.

Despite these achievements, however, AVU has been beset with a range of administrative, technical and academic problems, as Juma (2006) has noted in her report. To begin with, AVU has had to follow administrative policies and processes that are in line with local accountability requirements, making decision-making both slow and often inflexible, and co-ordination across national systems cumbersome and difficult. The African partner universities in the network have often perceived AVU as a competitor rather than a partner. The process for AVU to secure national and international accreditation for its courses has also been complex and has taken years. Costs have also been a problem, not only of the license fee charged by international partners but also of the technology infrastructure. Despite its advantages, the costs of delivering programs via satellite technologies have become prohibitive. It costs, for example, SUS 12,000 to deliver the required twelve hours of instruction per week per course (Juma 2006). This has of course meant higher tuition fees, making AVU courses accessible only to the African elite. Many of these students have transferred enrolment to the cheaper public universities as soon as they have been able to. Not surprisingly therefore AVU has consistently not met its enrolment targets and its graduation rates have been uniformly poor.

However, beyond these practical problems, it is perhaps more important to look at AVU’s operating model, and ask of the extent to which it represents a way forward, with the potential to bridge the digital divide. Here we encounter a number of conceptual concerns that reveal AVU’s philosophy to be underpinned by both a narrow view of access to higher education and an inadequate conception of the sources of digital divide. AVU functions on a model that seeks to tap the best international resources, programs that would otherwise be inaccessible to African students. It pays a license fee for the course content with the expectation that this content will be modified to suit the local conditions. And it is based on the assumptions that a skilled and entrepreneurial labor force developed through international programs are more likely to generate economic investment and productivity than the local programs, and that the ‘brain drain’ will be reduced because Africans will have international educational resources within Africa.

Now, each of these assumptions can be questioned. There is no guarantee, for example, that armed with international qualifications, the graduates of AVU programs will not want still to emigrate to western countries where their professional competencies are equally valued, and where a clearly-identified need for their skilled labor exists. That international qualifications will generate greater economic investment is also a highly questionable assumption, which is based on a deficit view of the quality of the programs that the existing African universities already offer. It reproduces a hoary colonial view of the capacity of Africans to develop their own programs appropriate equally to the local needs and conditions and to their engagement with the global economic processes. AVU had hoped that its international programs will be modified as a result of local input, but
this has been something that has been resisted by both by African students who want what they regard as an authentic overseas qualification and by international partners who have viewed this task as an additional burden for which they are not adequately recompensed.

It is clear that the AVU operating model is based on a market model that does not view transnational collaboration as intrinsically good, but a service that needs to be viewed as a cost within the licensing arrangements. It is not surprising therefore that earlier contribution by leading American institutions like MIT in providing short courses was not sustained beyond the first few years. Their participation was replaced instead by the more commercially-motivated operators like Australia’s RMIT and Curtin universities. In its current phase, AVU has become a corporate entity. As a non-profit organization with its headquarters in Nairobi, Kenya, it is now concerned more with its financial sustainability than with the broader issues of educational disadvantage in Africa. Its programs have been commodified, and it now competes with other providers, both local and international, for a greater share of the market in educational services. Within this market logic, it clearly provides access to online programs but only to those students who are able to pay. It thus works with a very narrow conception of educational access, inadequate for meeting the broader challenges of the digital divide.

Perhaps even more significantly, the AVU model appears to be based on a fundamental distinction between the development of the course content and its delivery. The course content is developed by international academics who are not themselves involved in teaching it and who often have little knowledge of the African context. It is left up to the tutors at the local learning centers to make sense of the material for African students. While this translation always involves processes of interpretation, appropriate and active negotiation on the part of the tutors and the students, the fact remains that the AVU’s pedagogic model itself is based on an assumption of unmediated reception of culturally neutral content. As a number of recent learning theorists in the socio-cultural tradition have pointed out, this is a fundamentally misguided view of how knowledge is acquired. The contexts of content design and its delivery cannot be so easily separated, and education is most effective when learners are not only consumers of knowledge and its active creators as well.

Another risk associated with AVU’s approach to bridging digital divide is that its efforts seem to be based on enlarging the users of content, rather than helping African scholars and students to draw upon their own knowledge traditions to engage with the knowledge that is circulating in the global media. The thrust of initiatives to bridge the digital divide should not be, as Besser (2005) has pointed out, to create a new body of digital age consumers but people who are able to become active participants in the global communication systems, able to produce knowledge that is appropriate to the local conditions and needs. Without the development of this capacity, Africans are likely to remain trapped within a global knowledge system, which while it connects the whole world into a series of networks of flows, does so selectively.
The current global system of knowledge is decidedly skewed towards the West. Much of the content on the Internet is produced in the developed countries, where English is the dominant language. As Castells (2000) has pointed out, the developed countries are able to leverage the opportunities offered by the information economy to further reinforce their economic power. He has argued that while the faultlines of marginality might not necessarily follow the current divide between North and South, it is difficult to see societies where education is grossly under funded, and where there is far too much reliance of knowledge products imported from abroad, closing the gap between themselves and those societies already at the core of information revolution. It is more likely that experiments like AVU will produce segments within African countries that are integrated into the global informational economy and culture, while the bulk of their population remains outside it.

What this analysis suggests is a different pedagogic model for Africa, into which global and local knowledge traditions are integrated. If the digital divide is to be challenged in a more serious fashion then such a model would seek to draw upon the enormous reservoir of knowledge available on the Internet, some of which free and which can readily be used as a result of such democratic initiatives as Creative Commons, but would seek to develop in students a capacity to critically interrogate them for their local relevance and utility. There is a huge gap at the moment in the appropriateness of online content for marginalized populations of the world, which threatens to reproduce and perhaps even greatly increase economic and social disparities. While much support and advice can clearly be provided by international organizations like the Commonwealth, the problem of digital divide, so stated, cannot ultimately be solved by anyone else but Africans themselves.

**Readings and References**


The development of cyberinfrastructure (CI) is greatly decreasing the costs of large scale data, instrument, and computational resource sharing, which is beginning to drive shifts in scientific practice and culture, and is poised to become a necessity for competitive next-generation research (Atkins et. al. 2003). CI is poised to change the manner in which we learn and will likely become a key driver of educational advances.

The National Center for Supercomputing Applications (NCSA) has coined the term Cyberenvironments to describe systems designed in terms of such an infrastructure and built to leverage network effects and support the evolution of new practices. Rather than focusing solely on access to advanced resources, Cyberenvironments emphasize the integration of these shared resources into projects and the integration of new resources created in projects back into the community-scale scientific context.

Growing out of research communities, CEs and CI will ultimately be as pervasive as personal computers and internet connections are today, in schools, in homes, in libraries, and virtually any space. Students and informal learners at all levels will have access to actual datasets, experimental tools, provenance trails, and the other offerings of cyberenvironments, and will be able to study how real science is done, and actually execute their own scientific research. Thus, the student (formal or informal) can “learn by doing” rather than to merely observe. By allowing the student access to such data and tools, and allowing them to create their own experiences, which are captured for the benefit of others, the notions of teacher vs. student become less distinct.

This chapter proposes some of the design principles needed to develop open, ubiquitous infrastructure that can be used and reused for many purposes. We present some present day research projects that are demonstrating implementations of these concepts.

Cyberenvironments: New Science Practice, New Learning

A mechanistic description of the World Wide Web – that it greatly simplifies sharing of text and multimedia information and enables links between documents – does not do a good job of conveying the true scope of its impact on society in terms of changes in practices and culture, the emergence of new businesses and career paths, and the extent to which our lifestyles have become dependent upon its existence. A similar story is emerging in science and engineering, as recognized by the National Science Foundation (Atkins et. al. 2003). The development of cyberinfrastructure (CI) is greatly decreasing the costs of large scale data, instrument, and computational resource sharing, which is
beginning to drive shifts in scientific practice and culture, and is poised to become a necessity for competitive next-generation research. Analogously, CI is poised to change the manner in which we learn and will likely become a key driver of educational advances.

Work over the last two decades in projects described as collaboratories, grids, e-Science, science gateways, and community databases has shown the direct potential of CI. More generally, the availability of directly accessible data, instruments, and computational resources have helped fuel a shift in scientific research towards multidisciplinary, systems-oriented studies and to close coupling of computational modeling with experimental observation. CI is helping to make such modes of research tractable at all scales.

With the Web as an exemplar, the focus in the development of CI is shifting from project by project efforts to the creation of a ubiquitous infrastructure available across all science and engineering disciplines. As discussed later in this chapter, the National Center for Supercomputing Applications (NCSA) has coined the term Cyberenvironments to describe systems designed in terms of such an infrastructure and built to leverage network effects and support the evolution of new practices. Rather than focusing solely on access to advanced resources, Cyberenvironments emphasize the integration of these shared resources into projects and the integration of new resources created in projects back into the community-scale scientific context. CEs are intended to support researchers in efficiently discovering, accessing, and integrating resources to explore new ideas and in disseminating their work, in a detailed and actionable form, to their colleagues. Implicit in this vision is the assumption that research results such as papers, processes, and data can be conveyed with enough information about themselves to be incorporated into further research work. This requires new infrastructure for managing metadata (i.e. what units are the data in) and provenance (which data was discussed in a paper, what analysis was applied to it).

This type of self-description can clearly supplement more formal learning materials. Further, its existence and an overall CI may change practices. Researchers will come to expect that training materials will be directly linked to the data and models in the CI, and that they can contribute, Web-style, to the body of training materials, examples, and exercises about shared resources. Increasingly, researchers will learn about new resources just-in-time, in the context of work activities.

As with the Internet itself, which began in the research realm, CI will also find broad use in education and in society as a whole and the expectations that one can move seamlessly from discovering something to understanding how it works to using it to exploring new ideas may lead to an interesting concept of ubiquitous learning: learning and learning materials linked directly into work/research contexts and with the global set of data and analysis resources, formal learning materials supplemented by user-created examples, extensions, and annotations created using the same mechanisms used to perform and document their own work.
CEs and CI will ultimately be as pervasive as personal computers and internet connections are today. They will be available in schools, in homes, in libraries, and virtually any space. They will enable researchers and students to access the data graphed in a lesson to re-plot it or reanalyze it, or find new data to analyze to see if the historical trends shown in the lesson continue to hold. By providing access to actual datasets, experimental tools, provenance trails, and the ability to perform analyses in the same environment used for learning, researchers will be able to quickly incorporate innovations by their peers into their own work and students at any grade level will be able to actively explore the consequences of scientific discoveries. Students will “learn by doing” rather than following rote exercises.

In the following sections, we highlight some early cyberenvironments and show some examples of how they have begun changing scientific and education practice, and then describe some of the design concepts that we believe will be required to realize the type of open, exploratory Cyberenvironments being discussed.

**Case Study: Cyberenvironments for Science and Engineering**

While the concept of Cyberenvironments will take time to mature, there are already projects that incorporate aspects of their design and architectural patterns to provide novel functionality. The National Center for Supercomputing Applications (NCSA) and other groups are engaged with a number of communities driving towards end-to-end Cyberenvironments tailored to their specific disciplines. Even at this stage, it is clear that cyberenvironments are not simply allowing researchers to accelerate their current practices. They are also allowing new types of research and collaboration that enabling study of more complex systems.

*The Collaboratory for Multi-scale Chemical Sciences (CMCS)*

CMCS (CMCS, 2007; Myers et al., 2005; Schuchardt et al., 2005) is a U.S. Department of Energy funded effort, led by Sandia National Laboratories and begun in 2001, that was designed to enhance information transfer between chemistry sub-disciplines, connecting quantum chemistry, thermochemistry, kinetics, and modeling of combustion devices, e.g. diesel engines. CMCS has had success in attracting international groups in a number of sub-fields who are coordinating their research efforts and acting as expert groups, publishing new data and models backed by rich information about their creation and ranges of validity. These distributed groups associated with CMCS have used the base capabilities of the system to: assemble and curate computational and experimental data, transparently exchange data between modelers who use different software with different file formats, and stage data for use with newly developed tools for statistically analyzing networks of thermo-chemical data to produce new reference data sets and for producing reduced kinetic mechanisms with guaranteed accuracy over a given range of conditions. In the area of thermochemistry, this new ability to gather data from researchers around the globe and analyze it together has resulted in a factor of ten improvement in the precision of our knowledge of the properties of important chemical species (Ruscic et al., 2005). The same tools used in this analysis are available to individual researchers to
perform ‘what-if’ analyses enabling them to broaden their perspective and understand the impact of their work not just as an isolated measurement but in terms of its overall effect on our knowledge of related chemical species. In a broader sense, CMCS as a whole has begun to aggregate the tools and data sets for researchers to learn, directly or through collaboration with other experts, about how their work impacts related fields of study moving from the level of atoms and molecules to combustion in engines and power plants.

Environmental CyberInfrastructure Demonstrator (ECID)

ECID is an end-to-end cyberenvironment prototype targeting use cases in the context of environmental research and planning activities related to the WATer and Environmental Research Systems (WATERS) Network (WATERS, 2007). ECID incorporates a collaborative portal, workflow and modeling capabilities, the ability to connect to streaming data sources, metadata and data provenance management, and a social networking based recommender system. The basic collaboration capabilities of ECID are being used to support the planning activities of the WATERS National Project Office. The more advanced capabilities of ECID are being piloted in research related to understanding the causes and effects of pollution in different water systems (e.g., Corpus Christi/Nueces Bays in Texas and the Illinois River Basin). ECID has also been used to demonstrate scenarios envisioned for future national environmental observatory efforts involving, for example, the ability to develop analysis workflows for streaming sensor data on the desktop and to then publish them to run on back-end servers to create new derived data products for the community. ECID is also exploring the use of data provenance and social network analysis (Contractor, 2005) to provide alerts and recommendations about relevant data and new techniques that are relevant to a researcher’s current efforts and to provide a dynamic, ”always-on” overview of community activities.

Looking at ECID as a model for future cyberenvironments, one can identify several key aspects. First, ECID reduces the differences in working with local and remote data and computational resources, e.g. by allowing local and remote data to be brought into workflows using the same interface, and by allowing workflows to be moved from desktop to remote resources. Second, ECID blurs the roles of end-user and contributor in that any user can be given permission to add data, documents, workflow templates, or new workflow processes to the system such that they become accessible to others in the same way as the original content. Third, ECID uses a number of strategies, from the basic use of workflow which helps make the logic of a program more explicit to new users, to the incorporation of group spaces and collaboration tools, to the global use of metadata, provenance, and network browsing and recommendation capabilities, to integrate learning and work activities into a seamless whole.

These capabilities enable researchers to explore analyses, with recommendations for tools and data that have been used in similar problems in the past. In addition, users may dynamically create work groups (Virtual Organizations) around problems of interest. These groups can share data and workflows, capture activities to guide other users as part of recommendations.
Agenda: Ubiquitous Cyberenvironments for Learning

The examples discussed above provide some sense of how CI and CEs are enabling new types of scientific coordination and enabling researchers to expand their studies to more complex systems and directly address problems of societal interest. These capabilities are not limited to science and engineering, nor to large, formal organizations. Similar collaborative activities are needed for business, public affairs, disaster management, education, and entertainment.

It is clear that this type of research will require a very organic set of learning materials ranging from relatively static material focusing on theory to examples and exercises that are updated as often as new data and new analysis processes appear. As noted previously, while the examples describe scientific research, the promise of CEs is much broader: in any highly creative endeavor, the roles of research, teaching, and learning become blurred and could benefit from software that enables dynamic transition between these roles. Typical usage involves:

1. Discussion and social networking, to design studies and recruit necessary expertise
2. Discovery of resources from many sources, including techniques, tools, data, and human knowledge
3. Iterative development of complex processes, based on best practices, evaluation of alternatives, collaborative assessment
4. Publication of data, techniques, and results.

In each of these activities, the participants are not passive consumers of “content”, they are actively contributing expertise in collaboration with others. In other words, a CE cannot function without UL.

If we accept the premise that learning is continuous and not limited to conventional educational settings, then we must ask how to build, deploy, and sustain learning experiences? Clearly, cost alone dictates that UL will be built on the universal infrastructure of the World Wide Web, national Cyberinfrastructure (CI) and emerging technologies for Cyberenvironments such as discussed above.

Ubiquitous Learning requires ubiquitous technology cost-effective large scale deployment and reuse, participatory learning, and communication and sharing, both synchronous and asynchronous. The “content” must be open, evolving, and user managed. The infrastructure must also provide flexible security, reliability, and persistence, without relying on specific platforms, products, or systems.

Scientists and other information workers can no longer remain isolated in the ideas and methods of their own discipline. To solve significant research problems, they must become engaged with a community of people and technological resources. Cyberenvironments (CE) provide seamless integration of technological resources, and
embedding disciplinary methodologies into software. By engaging in a research community that is supported by CEs, the researcher cannot help but learn the content, and methodologies of their collaborators. Indeed, the researcher’s role can become much more widely focused as part of a team solving problems that no individual could undertake successfully.

CEs go beyond individual applications and stovepipe problem solving environments, to provide ubiquitous software tools for collaboration, persistence, and access control. These “ubiquitous” tools are shared protocols, formats, services, and components, from which specific problem- and community-oriented solutions can be built. “Ubiquitous” means “wherever you are”—the same principles work everywhere.

The CE tools are designed to open and “repurposable”, a la Web 2.0 mash-ups such as enabled by Google Maps (http://www.google.com/apis/maps/). This enables new problems to be tackled by piecing together techniques and data on the fly from any source. A community environment will evolve by incorporating new procedures and new data regardless of the source. Concepts, data, and methods can be imported from other communities (though the importer may, perhaps, have a different purpose than the source).

Because of this open, evolving, “mashed up” design, people will play an active role in the CE: not as “users” and “providers”, but as participants. All participants will be able to contribute to the cumulative knowledge and armarium of techniques, and all participants will continuously learn—what methods and data are recommended to answer certain questions (and why), what questions should be asked, and, ultimately, what “works”. In such an environment there is no sharp boundary between “professional work” and “learning”, and every participant will play the role of teacher and learner throughout their active life.

These general purpose technologies provide the foundation for creating and sharing “content” of many types, as well as synchronous and asynchronous collaborations, sharing of tools and techniques, semantic search, and social networking. In these environments, experience and understanding can be documented (including provenance leading to that understanding), and shared using general purpose tools. In short, to create and conduct explicit pedagogy requires only the construction of the specific content and evaluation systems, with no programming or computer acquisition required.

Achieving ubiquitous CI requires easy knowledge transfer between tasks and situations. In addition, the generic mechanisms of the CE define a level of “literacy” sufficient to both participate in and initiate collaborative problem solving environments. For example, experience as part of a collaborative chemistry project will transfer directly to other online collaborations, such as an environmental science investigation. Direct, cumulative transfer of skill between tasks is absolutely critical to achieve ubiquity. In addition it will be necessary for participants to learn about the Cyberenvironment (what can be done, what is available now), and how to build and add to a Cyberenvironment (how to add content and capabilities).
Software Architecture Design for “Lack of Control”

To realize this vision of ubiquitous cyberenvironments, it is important to develop design principles that enable the development of open, reusable mechanisms. We note that the open, decentralized nature of contemporary Web applications (e.g., YouTube (http://www.youtube.com) or Google maps (http://www.google.com/apis/maps/) has enabled wide adoption, repurposing, and have achieved a vibrant success far beyond most scientific portals. These applications are characterized by a highly decentralized design, with much of the creativity provided “at the edge” by the users.

The users will experience a ubiquitous Web of information, processes, people, and social organizations, rather than “content” from “content providers”. Ubiquity requires not only simple, standard access (e.g., through web browsers), but also the cognitive experience that the mechanisms fade to invisibility, so activity and experience in one context can be transferred to another context. This can be achieved through application of design principles to create the right kind of openness. In other work, we have sketch general architectural patterns, that can be implemented with current and emerging technologies (Myers & Dunning, 2006).

These principles emphasize open interfaces and content-neutral protocols, which enable direct access to data and processes. For example, scientific collaborations need generic mechanisms for identifying objects and exchanging metadata, to enable sharing of data, models, and work processes (termed Content Management, Process Management, Context Management in (Myers & Dunning, 2006)). On top of these mechanisms, collaborating groups will impose their own views, defining common terminology, specific practices, and quality standards. This separation enables data, models, and processes to be shared and reused, without explicit, a priori agreements and standardization.

Conclusion

Direct access to data, instruments, and computational resources have helped fuel a shift in scientific research towards multidisciplinary, systems-oriented studies and to close coupling of computational modeling with experimental observation. CI is helping to make such modes of research tractable at all scales. The National Center for Supercomputing Applications (NCSA) has coined the term Cyberenvironments to describe systems designed in terms of such an infrastructure and built to leverage network effects and support the evolution of new practices. Rather than focusing solely on access to advanced resources, Cyberenvironments emphasize the integration of these shared resources into projects and the integration of new resources created in projects back into the community-scale scientific context.

Research results such as papers, processes, and data must be conveyed through the CI with enough information about themselves to be incorporated into further research work.
The existence of this type of self-description throughout the CI may change practices. Researchers will come to expect that training materials will be directly linked to the data and models in the CI, and that they can contribute, Web-style, to the body of training materials, examples, and exercises about shared resources. Increasingly, researchers will learn about new resources just-in-time, in the context of work activities.

This chapter has proposed some of the design principles needed to develop open, ubiquitous infrastructure that can be used and reused for many purposes. We presented some present day research projects that are demonstrating implementations of these concepts.

Growing out of research communities, CEs and CI will ultimately be as pervasive as personal computers and internet connections are today, in schools, in homes, in libraries, and virtually any space. Students and informal learners at all levels will have access to actual datasets, experimental tools, provenance trails, and the other offerings of cyberenvironments, and will be able to study how real science is done, and actually execute their own scientific research. Thus, the student (formal or informal) can “learn by doing” rather than to merely observe. By allowing the student access to such data and tools, and allowing them to create their own experiences, which are captured for the benefit of others, the notions of teacher vs. student become less distinct.

Readings and References

Chapter 12: Immersive Environments for Massive Multiperson Online Learning

Alan Craig, Steve Downey, Guy Garnett, Robert McGrath and Jim Myers

The majority of instruction offered via the Internet to date is Web-based and largely asynchronous in nature; immersive technologies, on the other hand, present new opportunities for shared, collaborative, and synchronous educational experiences. Furthermore, as these physically immersive environments and technologies evolve, there is a blurring of the line between what is physical versus what is virtual and as a result there is an ever increasing opportunity for delivering engaging situated learning and promoting increased interaction between learners, teachers, the content, and each other. This chapter discusses how massive multiperson online learning environments extend the concept of ubiquitous learning and can change the very nature of online instruction.

Due to their highly interactive, persistent, and collaborative nature, massive multiperson online learning environments provide exceptional opportunities for advancing research and educational practices associated with a variety of learning theories, including Inquiry-based Learning, Situated Learning Theory, and Social Development. Such systems are also evolving toward supporting heterogeneous hardware devices and user interfaces, including cellular telephones, gaming consoles, multimodal virtual reality interfaces, and others.

As an illustration of these ideas, we discuss as a case study the class, “Art in Virtual Worlds” (2006), in which students worked together in an online virtual world, Second Life (SL). Virtual worlds are easy to learn and fun to experience, so students spend more time in world. Unlike other shared spaces (such as web based), shared virtual worlds enable safe, easy contact with large communities and promote a greater sense of user presence: you get to see other users (or at least their avatars) while you are in the shared space. You can also work on projects together, much as you can if you were actually in the same room together.

Realizing the promise of these environments will require ubiquitous, scalable infrastructure, such as discussed in the Myers et al. chapter of this text. In addition, we need open frameworks with flexible mechanisms for creating content and worlds as well as further work on instructional frameworks for ensuring sound pedagogical principles and engaging learning activities.

Thesis: interactive, persistent immersive environments will provide revolutionary new ways to teach and learn

The majority of instruction offered via the Internet to date is Web-based and largely asynchronous in nature. While this affords great flexibility for learners to access materials when and where they want, its comparatively static and solitary nature leaves
learners isolated both from their peers and from experts and unengaged with the content. Immersive environments deviate from this model by enabling interactive engagement between subject matter experts (who at times are learners) and learners (who at times are subject matter experts), and by making the content more interactive and experiential—these attributes combine to make the virtual world better approximate the real and to increase its ability to positively impact learning through virtual experiences.

In the future, three dimensional, immersive environments will further break down the borders of what is ‘virtual’ and what is ‘real’, blurring the distinction between that which exists in the physical realm vs. that which lives only in the digital domain. This will enable situated, experiential learning to take place outside of the actual physical situation. Real world objects can already be scanned and brought into the digital space, environmental data of all kinds can be captured with sensors, and digital objects can be “printed” as three dimensional solid objects. As these techniques become cheaper, easier and more widespread, they will enable more, and more realistic, virtual experiences that can be used for teaching and learning.

Many virtual worlds are also persistent. This means that they are always there and your actions affect the world. The persistence allows learning to occur anytime and, potentially at least, allows the learner to pick up where they left off. As alternative means of access to virtual worlds are further developed, one will be able to access a particular world not only through desktop computers, but through a variety of mobile and ubiquitous interfaces. The important point is that the virtual world is persistently available, regardless of the means of interfacing with it. This means these persistent virtual worlds provide different channels through which learning can occur, and are ubiquitously available via multiple means of interaction.

This chapter presents this new approach for delivering instruction via the Internet that capitalizes upon the affordances such persistent virtual worlds offer as a ubiquitous learning framework that can build on the successes of massive multiperson online environments such as World of Warcraft (http://www.worldofwarcraft.com), Second Life (http://secondlife.com/), and Lineage (http://www.lineage.com/). In presenting this new model, we discuss the vision foreseen for these new environments, an instructional framework for engaging learners, and the technical drivers and challenges accompanying these worlds.

“Virtual Worlds”: Persistent Immersive Environments

Current online learning environments are woefully inadequate in two key areas – interactivity and situating of instructional activities (Ogata & Yano, 2004). Web-based environments fail to convey the real world environmental challenges associated with, for instance, collecting samples of offshore plants, or conducting remote musical performances of students in an online music composition course. Immersive multiperson online learning environments provide visual and simulated physical affordances that more accurately mirror the real world environments in which the knowledge is to be applied, which can provide opportunities for situated learning and increased interactions between learners, their content, and each other. In the future, these environments will be
more widely accessible through mobile devices, and more physically engaging through immersive technology enabling participants to participate bodily in these interactions.

It is important to draw a distinction between mental immersion, and physical immersion. Mental immersion is the state that a person is in when they are cognitively absorbed in the content of some virtual world regardless of the medium in which that virtual world is manifested. For example, a person can be mentally “immersed in a good novel,” or “immersed in a movie,” or “immersed in an online gaming environment.” Physical immersion substitutes, or augments the stimuli to one or more of a person’s senses. Thus, to be physically immersed in a virtual world, technology must provide a synthetic stimulus to the end user in a manner that is appropriate for the simulated condition (Burbules, 2004; Sherman & Craig, 1995, 2003).

It is not always necessary, or desirable to occlude the “real” (physical) world to the participant. It is sometimes advantageous to integrate synthetic stimuli in registration with real world stimuli to augment the physical world by superimposing the virtual on it. For example, a participant could visit a museum and have annotations and extra information about the exhibits displayed as overlays on the real exhibits. In addition, some participants may be physically immersed, while others might be interacting via a two dimensional interface on a computer, or via their cell phone.

Today, full physical immersion is available only in a few special installations. However, contemporary entertainment industries have driven commercial technology toward extremely high quality graphics and sound systems, connected by high bandwidth channels in homes and desktops. Massively Multiplayer Online Games (MMOG) have evolved into complex “synthetic worlds” (Castranova, 2005), shared, persistent, immersive 3D environments in which people live out fantasy and reality. This technology presents tremendous opportunities for creating flexible and diverse collaborations, new forms of understanding, and compelling educational experiences. Furthermore, the success of contemporary online games offers a model for how to create persistent, shared, immersive environments. We would like to exploit and extend this successful technology and associated metaphors to create high-quality, low cost software accessible to a broad range of users.

As physically immersive environments and technology evolve, there is a blurring of the line between what is physical and what is virtual. These technical developments are leading to the emergence of persistent virtual worlds, which provide greater opportunities for situated learning and increased interactions between learners and their content and with each other. The following case study illustrates the experience-driven nature of these online learning worlds and how these sensory rich environments compel learners to explore and become engaged in their world and their lessons.

**Case Study: Art in Virtual Worlds**

One of the authors (Garnett) conducted a class at the University of Illinois called “Art in Virtual Worlds.” This section gives informal impressions from the perspective of a teacher.
In the evening after dinner on the day of our first class, in which I introduced the merest rudiments of travel and interaction in the virtual world called Second Life, I decided to check in and see how—or even if—the students were getting along in it. To my surprise, I was immediately hailed on the Second Life internal chat (a kind of Instant Messenger service for people in world) by an excited student, a young woman I will refer to as “S.” S told me I simply had to come see what she had found. In our afternoon class I had merely suggested to students that they wander around Second Life and explore on their own, but to be prepared to report back to class on anything “interesting” they had found. Well, S insisted we fly off right then and there to a place she had already landmarked (the Second Life equivalent of a browser bookmark). After a brief teleport (the fastest way to travel long distances in Second Life) we materialized at a telehub and covered the remaining distance by flying (the second fastest way to get around in Second Life is to have your avatar leap into the air and travel in the direction desired, à la Superman.) Confidently, S led us directly to the object of interest she had identified: a luscious and elaborate garden. I was taken immediately by the life-like fluttering of butterflies from one blossom to another. As we entered, to a constant stream of chat from S describing all the wonderful details—including sounds of birds and frogs— we came upon the chief attraction of this particular garden: a 25 foot high waterfall cascading over granitic rocks.

This entire experience was rather enjoyable to me on a number of levels. On one level, there was a very personal sense of excitement and anticipation as we flew toward what obviously was a very exciting discovery by a student. On another level, as a teacher I was amazed how different this experience was from the “reports” I had expected to hear in our next class. There was little need for S to describe to me what she had found, she brought me into a direct co-experience with her. That experience is qualitatively different from the many emails containing URLs that I receive from students pointing me to one page or another of class-related research or news, it is even substantially different from the IMs and other real time chat that we all know so well. I am fairly certain I would not have remembered so viscerally, in such detail, the garden and the waterfall, not to mention which student had discovered it and shared it, if it had been a simple text based, or even text plus graphics, class report. This shared sense of presence is a critical attribute of virtual worlds. It heightens the participant’s experience and leads to greater retention. It is not so much the boundary between virtual and real is blurred; it is that the boundary disappears entirely. My student and I were not two people engaged in some kind of computer-mediated communication: we were two people in one shared experience.

This sense of shared experience continued throughout our semester in Second Life. We almost always resorted to such direct experience when students presented their projects (see Figure 1). In fact, the students would often be logged in to Second Life during class, and I would be displaying my avatar’s point of view on the class projector, with student avatars coming on screen to point something out or materialize something relevant (usually) from their inventory (a
kind of storage system that allows you to carry things around with you, things as small as text files or as large as cars and houses).

Another key aspect of our class was to form collaborative teams: we had students from computer science, music, art, and a variety of other majors. The online interactions turned our collaborative class projects into nightly social events. Students checked in to Second Life to see what the others were doing, to chat, to share some new find, or generally just to hang out. As they worked they naturally discovered each other’s strengths, and no doubt weaknesses as well, and learned from each other and taught each other. Rather than the usual collaborative tactics that rely heavily on one, “most motivated,” person to make sure things happen, they built objects together, in shared virtual space, much more then they usually would get together in real space. A part of this is convenience: even if someone was out of town, visiting family on a weekend for example, they still often managed to get on to Second Life. It was also far easier for them to get on to Second Life from their dorm then it would have been to go in to the lab, especially late at night. Another part of this was just the curiosity factor: students want to see what the other students are coming up with and not having to walk or get a campus bus over to a lab made it far easier to do so with little or no planning and minimal consequences.
One other aspect of teaching in Second Life took me completely by surprise. The class, including me, interacted with a far wider range of people who were not in the class. This included friends, and sometimes family, of students, but it also included random passersby who saw us building something intriguing and came over to have a look at what it was and chat with the students creating it. These passersby were from all over the world, were in fact somewhere else in the world at the moment connected only by the internet. In other words, our “virtual lab” became part of a larger community, a vast and varied “town” that was completely autonomous to our “gown,” yet was able to both lend the students appreciation and advice during the process of creating art in a virtual world.

Some important conclusions for education:

- Because it is easy to learn and fun to do, students spend more time in world. This finding is consistent with recent polls of MMOG users (see Figure 2) in which users spent an average of 3-4 hours per day in the virtual worlds of massive multiperson online environments. At least up to a certain point, the more time they spend, the more they learn. More complex things take more time/skill, but simple things are easy.
The nature of such a space (such as SL) enables safe, easy contact with a larger community, resulting in mostly positive feedback and the sense of participating in something larger and paradoxically more “real” then a classroom project. Furthermore, it is relatively easy to find kindred spirits, advertise your work, and connect to new communities.

Unlike other shared spaces (such as web based), shared virtual worlds enable a greater sense of presence: you get to see other users (or at least their avatars) while you are in the shared space. This facilitated sessions from home or dorm, and led to more concrete collaboration. Rather then simply breaking up large projects into subprojects that could be worked on individually, students spent more time actually interacting together.

**Instructional Framework for Ubiquitous Learning in MMOLEs**

The shift towards ubiquitous learning is leading to a new model for lifelong learning, community building, and learner engagement. These mentally immersive, massive multiperson online learning environments (MMOLEs) provide radically better and new features for:

- **Experiential learning** — the strong sense of user presence and naturalistic interactions enable rich, pseudo-realistic experiences for situation-based learning.
- **Collaborative learning** — the presence of multiple people and actors, along with a shared, persistent ‘world,’ promotes collaborations and community building.
- **Creativity** — the ability for all participants to create and share “content,” up to and including whole ‘worlds,’ enables new kinds of learning through visually compelling self expression and creativity by learners.

Due to their highly interactive and collaborative nature, MMOLEs provide exceptional opportunities for advancing research and educational practices associated with a variety of Constructivist learning theories: Inquiry-based Learning (Dewey, 1964; Edelson et al., 1999), Situated Learning Theory (Lave, 1988), and Social Development (Vygotsky, 1978). The degree of interactivity and collaboration afforded by such environments will require new learning theories and ‘best practices’ to capitalize on their capabilities.
To that end, a preliminary instructional framework is proposed; see Figure 3 (Downey, 2007). This framework incorporates elements from each of the three theory bases mentioned while remaining extensible to allow educators to integrate their own unique contributions based upon the instructional content and needs of their learners. It also incorporates the notion of the ‘quest’ from role-playing games such as World of Warcraft. Briefly stated, instruction begins by generating curiosity in learners – exposing them to problems and scenarios to get them exploring situations and asking questions. To help guide them, learners are presented with a more directed learning activity, similar to a game quest, stating their learning goal and providing instructions for discovering needed information and possible collaborations with their peers. Using their learning quest instructions, learners set about their activities, navigating their virtual world, discovering and accessing data and information needed for their quest, sharing knowledge with their peers, and observing and interacting with the context and situation surrounding their learning activity. Another crucial element from games enters in here, one that is critical to maintain student interest: the pursuit of the quest must be engaging and its solution must be rewarding. At stage four, “Assemble Knowledge,” learners formalize the initial ideas and mental constructs they have established for their learning quest by interpreting information, assembling knowledge, testing hypotheses, and generating solutions. Finally the quality of the learner’s knowledge is assessed and feedback is provided guiding the learner to areas of improvement and/or providing connections to additional quests that build upon the learning completed and generate a whole new level of curiosity and inquiry in the learner. Each of these learning stages can be present in varying degrees, they need not be rigorously sequential and discrete.

While the state of the virtual world is dynamic and the collaborations are synchronous, the learning quests and content may be either synchronous or asynchronous: as in games, some quests may require coordination and collaboration with other learners. Therefore, learners can access their learning quests and collaborate with their peers at anytime and from any location from which a network connection is available.

**Technical Challenges**

In order to provide ubiquitous, physically immersive spaces, numerous technical hurdles must be overcome. Perhaps one of the most critical is some means by which to do wide area tracking of the physical location and posture of participants. All aspects of creating truly immersive spaces need higher fidelity, which requires bandwidth, computing power, and higher resolution (both temporally and spatially) transducers. Even given solutions to these technical issues, widespread adoption of such a MMOLE paradigm requires an order of magnitude increase in the flexibility and tools available for teachers and others to create appropriate virtual worlds for their students.

Game engines have adopted a few standardized approaches to integrating graphics, networks, databases, physical models (physics), networking, scripting, and game play. These approaches may be used in straightforward, obvious ways, but need to be extended to enable interactive learning and research. For example, the notion of “physics” in games allows us to define how scientist, teachers, and student avatars could interact with
data and its visualization and this could be used to represent many different aspects of the data model in a tangible manner.

Current synthetic worlds are constrained in ways that prohibit the full range of activity and interactions needed for ubiquitous learning. In particular, none of them are scalable in the ways we envision, none of them have the high levels of data and transaction security that are necessary for some applications (e.g., to support digital commerce), and none of them supports the input, display, and manipulation of large amounts of diverse, time-critical, real-world data, from databases, sensors, imaging systems, etc. There are further challenges in meeting the requirements for manipulation and interaction necessary for experimentation while maintaining the social affordances of the environment. Specifically, learners may need to control the temporal dimension of their interaction with a virtual space and be able to discover or create alternate realities/alternate histories for the same physical space from within the environment itself. For example, studying different phenomena within a simulated ocean bay may require interacting with it on vastly different timescales, which would make chatting with other occupants of the same space difficult. Similarly, if quests involve manipulation of the space (e.g. raising the temperature to observe the effect on glacial melting), indicators may be needed to show when results accurately represent the real world or are based on scientific consensus versus simply being a ‘what-if’ exploration and learners may need to find and compare alternate scenarios.

Realizing the full promise of these environments will require open frameworks with flexible mechanisms for creating content, which will be built on ubiquitous, scalable infrastructure, such as discussed in Myers et al. chapter of this book.

**Conclusion**

“Virtual Worlds” are rapidly emerging as a social phenomenon, and are already called upon to serve as a medium for learning and teaching. Enormous potential is evident even in today’s primitive systems, such as Second Life.

To realize the full potential of this technology for ubiquitous learning will require technological and pedagogical developments. This presents some key technological challenges of interfaces, software architecture, and cyberinfrastructure. We also emphasize the need for better understanding of teaching and learning in these environments, best practices, and toolsets to enable broad participation and unleash the creativity inherent in a ubiquitous learning environment.

**Acknowledgements**
The National Center for Supercomputing Applications is funded by the US National Science Foundation under Grant No. SCI-0438712. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

**Readings and References**
Chapter 13: Let’s Get Serious about E-games: A Design Research Approach Towards Emergence Perspective

Wenhao David Huang and Tristan E. Johnson

E-games’ Omnipresence is Inevitable

The advancing communication and information technology has made E-games ubiquitous by lowering the cost of computers and game consoles manufacturing (e.g., PlayStation®, Nintendo Wii™, etc.), increasing compatibility between E-games delivery platforms (e.g., off-line and on-line), and streamlining the process of game development. For the scope of this chapter, E-games encompass all games that require computer processors to deliver the game playing process and game environments. They could be computer games delivered from your networked PCs and Macs, console games delivered through your televisions, or mobile games delivered by your cell phones. Playing E-games is no longer an expensive recreational activity but one relatively affordable for everyone. Furthermore, this trend is observable across generations, directly impacting the delivery of formal and informal learning. Learners who are now in the pipeline of our formal educational systems playing E-games and, more importantly, learners who are about to enter the K-16 educational system playing them, will have grown up with E-games. With the introduction of Nintendo Wii™ technology, older generations too can easily interface with E-games for various learning purposes (e.g., physical rehabilitation to help patients relearn lost abilities) (Miller, 2007). Playing E-games, whether it is in or out of the classrooms, has become part of many people’s daily lives and the inevitable reality is that it soon will become a preferred means of communication heavily utilized by future generations.

E-games for Learning

E-games can be described from two approaches: game playing process approach and game component approach. E-games’ playing process is essentially the same as of those non-E-games (e.g., board games, card games, etc.). E-games’ components, however, are more complicated than non-E-games owing to the interactions involved particularly for the purpose of enhancing learning experience.

From the game playing process approach, E-games are entertaining to play. Although players need to follow rules in the game (e.g., online chess), it is equally important for players to experience freedom, uncertainty, and unpredictability during the game playing process (Caillois, 1962). Abt (1968) defines the process of game playing as “any contest among adversaries operating under constraints for an objective”. Suits (1990) summarizes it as the “voluntary effort to overcome obstacles”. Some might argue, however, the term “contest” does not fully describe the fun and entertaining aspects of playing games (Gredler, 1994). E-games playing also could be a less entertaining and
more serious activity in the context of learning. This requires players to make series of decisions to achieve predetermined game objectives (Apt, 1970). In 2002, The Woodrow Wilson International Center for Scholars launched the Serious Games Initiative (2007) to promote the benefits of using games delivered via computers or game consoles as training and educational tools to develop complex skills in various industries (e.g., military, higher education, health care, etc.). The Federation of American Scientists (2006) further advocates that educators should better utilize video games’ powerful effect in educational settings to enhance intended learning processes.

From the game component viewpoint, Crawford (2007) identifies four independent and yet interconnected computer game components: representation, interaction, conflict, and safety. The representation of the game system consists of all participating agents (e.g., players, system interface, game rules, game objectives), which enables intended interactions. Conflict could be the means and/or the end of interactions, which requires players to dissolve complicated situations. The safety component allows players to experience the outcome of their game playing actions without experiencing any real harm. To confirm the complex components of E-games, Amory (2007) suggests that games should include Game Space (play, exploration, authenticity, tacit knowledge, etc.), Visualization Space (critical thinking, storylines, relevance, goals, etc.), Elements Space (fun, emotive, graphics, sounds, technology, etc.), Problem Space (communication, literacy level, memory, etc.), and Social Space (communication tools and social network analysis), in order to fully harness E-games’ effect on learning.

In summary, E-games for learning should be entertaining to play while players aim to attain serious game objectives with actions guided by rules. Furthermore the intended game playing process requires purposeful design of interactions aligned with learning and afforded by complex game structure.

**Games’ Multidimensional Characteristics**

In addition to the convenient access to E-games, their multidimensional characteristics play a pivotal role in engaging players in this ubiquitous trend. Ten interconnected game characteristics have been repeatedly reported in existing literatures on E-games, see Table 1.

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**Presenting challenge**

A challenging activity is achievable, unpredictable, clearly defined, and designed to stretch and flex players’ existing knowledge or skill levels. (Baranauskas, Neto, & Borges, 2001; Bennett, 2007; Belanich, Orvis, K., & Sibley, 2004; Csikszentmihalyi,
1990; Garris, Ahlers, & Driskell, 2002; Malone, 1981; Malone & Lepper, 1987; McGrenery, 1996 in Kasvi, 2000; Rieber, 2001). For example, the difficulty levels inherent with different stages of Mario Brothers® challenge players’ problem-solving skills and console controlling skills whenever players move to the next level.

**Competition**

Competition equates to contest, which implies the application of rules to identify winners. Players may compete with the game system (e.g., arcade game with single player), individual players, or teams to achieve the game objectives. Players develop and refine their skill levels by fully participating in the competitions (Baranauskas et al., 2001; Crawford, 1982; Csikszentmihalyi, 1990; Rieber, 2001; Vockell, 2004). Chess game is an exemplary example of players competing with each other in a constrained-by-rules environment.

**Rule-bound actions**

Game players follow rules to carry out every move in the game. Playing games without rules makes the entire process meaningless. The constraints of game rules ensure fair play for all players and they can be an explicit or implicit translation of intended instructional messages. (Bennett, 2007; Björk & Holopainen, 2003; Garris et al., 2002; Hays, 2005). For example, players need to throw the dice to determine how many steps he or she can move in the Monopoly game.

**Goal and task-oriented play**

Game goals explicitly identify the desired game outcome in various forms (e.g., final scores) to guide game players’ actions. They also serve as the criteria for players’ final performance assessment. (Bennett, 2007; Björk & Holopainen, 2003; Csikszentmihalyi, 1990; de Felix and Johnston, 1993; Gredler, 1996; Hays, 2005; Hirumi, 2006; Malone, 1980). Game tasks are the building blocks of game goals. Players need to accomplish a series of game tasks, in predetermined sequence, in order to reach the final goal stage. Game tasks also can be considered as the formative evaluation of players’ skill development process (Björk & Holopainen, 2003; Gredler, 1996 from Hays, 2005). In the game of Monopoly the goal is to be the wealthiest person among players. The player can only achieve that goal by accomplishing series of tasks such as purchasing railroads, managing real estate, profiting from investment, etc.

**Situated in fantasy and modified reality**

Games enable players to experience fantasy. In other words, players might have the experience that is impossible for anyone to acquire in reality (e.g., Star Wars games). This particular characteristic sets games apart from simulations. (Bennett, 2007; Garris et al., 2002; Kirriemuir & McFarlane, 2006; Malone, 1981; Malone & Lepper, 1987). Modified reality in games mimics the real world to certain extents, but not entirely. Players might be placed in a different context (e.g., role, time, space, culture, etc.) to experience the process (Belanich et al., 2004; Björk & Holopainen, 2003; Crawford, 1982; Csikszentmihalyi, 1990). For example, WWII combat games enable players to reenact part of history.
**Storyline or representation guides actions**

Storyline or representation in games provides the overview of the entire game playing process. It adds contextual references to the game environment. The storyline also helps players make sense of the game goals, tasks, and rules. (Hirumi, 2006; Rieber, 2001). The storyline of D-Day in WWII, for example, immediately sets the tone of the game for players, which consequently might facilitate the game playing process.

**Stimulating engagement and curiosity**

Games engage players by allowing them to immerse themselves completely in the game playing process. Players no longer consider themselves external to the game. Instead, they are part of the game and they are intrinsically motivated. Competition, curiosity, and mystery are often implemented into games to enhance games’ effect on engaging players (Asgari, 2005; Bennett, 2007; Csikszentmihalyi, 1990; Malone (1980) in Asgari, 2005; Malone & Lepper, 1987; McGrenery (1996) in Kasvi, 2000).

**Role-playing is essential**

Role-playing ties closely with the challenge, fantasy, storyline, and engagement of games. Players stretch themselves in all aspects if asked to role-play a game character. Role-playing further enhances games’ effect to allow players to experience fantasy (Björk & Holopainen, 2003; Gredler, 1996). Console games based on real sports (e.g., baseball, basketball, hockey, etc.), for example, allow players to be the Most Valuable Players (MVP) of certain seasons, for a higher level of engagement.

**Allowing player control**

Games provide a wide array of control options for players, to help players establish identities in the game. For example, E-game players usually create avatars to represent himself or herself. Players can design the avatars’ hair styles, eye colors, clothing, accessories, etc. Furthermore, the game control encourages players’ full participations by allowing players to take ownership of their plays (Belanich et al., 2004; Bennett, 2007; Csikszentmihalyi, 1990; Garris et al., 2002; Gredler, 1996 from Hays, 2005; Malone, 1981; Malone & Lepper, 1987; McGrenery (1996) in Kasvi, 2000).

**Heavy utilization of multimodal presentation**

This characteristic is at its best in E-games. Multimedia representations are heavily utilized in computer games and video games. Such application, in addition to enriching the game playing experience by making it more appealing and authentic, also helps players develop visual and spatial skills (Bennett, 2007; Björk & Holopainen, 2003; de Félix and Johnston, 1993 in Hays, 2005; McGrenery, 1996 in Kasvi, 2000).

**The Missing Pedagogical Link**

E-games, driven by three interacting elements, are reaching the tipping point to impact how future generations learn. Firstly, playing E-games has been recognized as a socially acceptable activity across generations. Soon it will become the necessity of communication corroborated by the fact that the hardware needed to deliver E-games too
is more readily available than ever. Secondly, E-games are capable of engaging learners with their multidimensional characteristics. Their potential to enhance learning experience in general, and to facilitate the development of complex skills, is eminent (Federation of American Scientists, 2006). The third element, or the pedagogical link, however, is still missing. How can educators efficiently and systematically integrate E-games into learning processes? The lack of empirically proved educational E-games design model requires educators, E-games designers, learning scientists, and E-games players’ immediate attention. Simply replicating E-games’ complex and interaction-rich structures in learning environments without considering their pedagogical impact might hamper the process of learning such as overloading learners’ cognitive load (Ang, Zaphiris, & Mahmood, 2007).

In order to preliminarily establish the missing link, educators, learning scientists, and game designers must take theoretically grounded approaches to purposefully align E-games’ characteristics with intended learning outcomes (Gagné, & Driscoll, 1988). Post hoc analyses on existing E-games’ effect on learning may further our understanding to some extent. However, researchers still seldom confidently identify the correlative or causal relationship between certain game characteristics and learning outcomes (O’Niel, Wainess, & Baker, 2005). Without such practical knowledge in place the design process of educational E-games would be inevitably inefficient. Given that the primary purpose of designing educational E-games is to enhance learning experiences while engaging learners with E-games’ appealing characteristics, a design research methodology guided by existing instructional design models is desperately needed. This will help us address the missing pedagogical link. The selection of instructional design models should follow the following criteria:

- Capable of designing complex interactions and learning environments across platforms such as E-games
- Scalable to accommodate various scopes of design projects and E-game characteristics
- Flexible to design linear, non-linear, branched, and webbed learning sequences seen in E-games
- Grounded in learning theories to align with intended learning outcomes
- Able to sustain performance transfer to help learners transitioning from gaming environments to real performance settings

An Example
The Four Components/Instructional Design Model (4C/ID-model, van Merriënboer, Clark, & de Croock, 2002) is an exemplary design model example fitting the aforementioned selection criteria. This model’s Learning Tasks design approach matches well with E-games’ emphasis on game goals and tasks. Other game characteristics can also be easily implemented into the design model. See figure 1 for the visual presentation of the 4C/ID-model (van Merriënboer, Clark, & de Croock, 2002).

The 4C/ID-model consists of four non-linear, interrelated design components:

- **Learning Tasks** are concrete, authentic, whole-task experiences that are provided to learners to promote schema construction for nonrecurring aspects of tasks and rule
automation. Learning Tasks must be complex and require the coordination and integration of all constituent skills. Task classes are used to define simple-to-complex categories of Learning Tasks on the basis of knowledge body (i.e., mental models and cognitive strategies). Learners are required to elaborate upon their existing knowledge base when given a higher task class. Supports are also available for Learning Tasks to facilitate the problem-solving processes.

- **Supportive Information** supports the learning and performance of nonrecurring aspects of intended tasks with concepts and theories. It should promote learners’ cognitive effort to relate new information with existing schema structures.
- **Just-in-time Information** helps learners develop automated responses. Rules and principles are essential to this design component. Demonstrations and examples, for example, are often applied in this component.
- **Part-task Practice** promotes rule automation for selected recurrent aspects of the intended complex task. The design approach aims to gradually develop learners’ ability to automate the performance of recurrent skills via small task building blocks.

The main design goal for adapting 4C/ID-model for educational E-game design is to situate learners in authentic and complex learning environments represented as games. With regards to implement game characteristics in 4C/ID-model design components, Learning Tasks could encompass the game goals, rules, game tasks, challenge, and competition for E-games, while Supportive Information could readily provide the fantasy element or game storyline. Another important aspect of the E-game design achievable by 4C/ID-model is its emphasis on the design of the interactions among all design components. The 4C/ID-model, as an example, has great potential to design complex E-game learning environments enriched with fluid interactions, concrete and interconnected learning tasks, abundant active and experiential learning activities, and multimedia presentations, enabling learners to transfer desired performance beyond the context of E-games.
Moving Towards an Emergence Perspective

Not all existing instructional design models, however, are appropriate for adaptations for educational E-game design. The adaptation process must be examined by rigorous and empirical design research guided by innovative design theories. The emergence perspective of system design based on observations of ant colonies, human cities, molecular biology, and computer science (Johnson, 2001), at the current time, seems to best respond to the need of shifting conventional instructional design’s centralized design approach to a more flattened, multilateral, and interaction-rich design process, for educational E-games design. The emergence perspective advocates a design process that does not require centralized top-down control and instead, uses the interaction and feedback generated by all design components to forward the design process, which is considered an efficient method in designing technology-rich learning environments such as video games (Irlbeck, Kays, Jones, & Sims, 2006). This new system design approach further reminds us not to rule out the possibilities of creating new interdisciplinary design models to satisfy the new needs presented by educational E-game design.

After all, the ultimate goal of this much-needed design research is to empower everyone with practical E-game design models and processes. Therefore we can fully capitalize the process of game playing for diverse purposes of ubiquitous learning.
Readings and References

For fundamentals of game design and instructional design theories and models, interested readers can explore these three books:


Chapter 14: Access Grid Technology: An Exploration in Educator’s Dialogue

Sharon Tettegah, Cheryl McFadden, Edee Wiziecki, Hanna Zhong, Joycelyn Landrum-Brown, Mei-Li Shih, Kona Taylor and Timothy Cash

Access Grid Technology: An exploration in educator’s dialogue

Human computer interaction and networking technologies such as video conferencing tools have prompted many research studies in multiple fields (computer science, communication, psychology and education) to investigate the use of media technology as collaborative tools. Most literature in the area focuses on either point to point video collaboration tools or email and listserves as communication tools with little research on multi-point collaboration tools. Recent “research in education suggests there are many advantages in using multi-point collaborative tools and Web-based technologies” (Tettegah, 2005, p 273). In this chapter we provide a brief overview of multipoint collaboration systems, and challenges and opportunities of using Access Grid technology (multi-point collaborative tool) to view animated narrative vignettes (ANVs) and to engage educators in dialogue.

Synchronous Tools and Video Conferences Tools
Several interesting projects on multi-point collaboration learning in the last decade are described in the literature (Clark, 1992; Fox, Wu, Uyar, Bulut, & Pallickara, 2003; Gong, 1994; Lopez-Gulliver, Tochigi, & Sato, 2004; Patterson, Hill, Rohall, & Meeks, 1990; Sonnenwald, Whitton, & Maglaughlin, 2003; Watabe, Sakata, Maeno, Fukuoka, & Ohmori, 1990; Zhu, Kerofsky, & Garrison, 1999). However, most of these studies describe group collaboration using Polycom teleconferencing and videoconferencing systems and web conferencing tools. Multipoint videoconferencing means three or more participants are involved in a teleconference. There are several great multipoint collaboration tools available for both business and educational purposes, but one of the most powerful tools available on the market is the Access Grid. While many point to point systems are available, we focus on a few, with a specific emphasis on Access Grid technology.

Multi-point Video Collaboration and Conferencing Tools
Multipoint collaboration technologies provide the real time transmission between three or more locations. Since multipoint collaborations involve participants at two, and primarily three or more sites, there are usually some basic requirements such as technical supports, audio/video control, network service and a conference environment. These requirements are all important for conducting successful multipoint conferences and collaborations, because in order to effectively share the experiences with others using digital multimedia data, a multi-user interaction environment is necessary. In addition, multi-point mode users can work in parallel or synchronously to interchange opinions.
The SenseWeb system is an example of a multi-user interactive information environment (Lopez-Gulliver et al., 2004). Equipment includes several multimedia technologies such as cameras, common halogen lamps as infrared light source, and a piece of software to turn any rear projection screen interactive and multi-user capable. The purpose of the SenseWeb system is to support shared experiences and collaboration among multiple users. The system allows users to simultaneously interact with digital multimedia elements by using their bare hands. A multi-user system such as the SenseWeb also means multiple users can actively interact with the data simultaneously.

Lopez-Gulliver et al. (2004) looked at the effectiveness of SenseWeb’s multi-point capabilities. Results from this study indicated 19 out of 20 users revealed the SenseWeb system was easy to use. Most of the users appreciated the dual capabilities of the multi-point mode of being able to work in parallel or in a synchronous way.

MERMAID. Other systems such as MERMAID (Multimedia Environment for Remote Multiple Attendee Interactive Decision-making) engage users through a specialized architecture. MERMAID is designed based on group collaboration system architecture, which provides an environment for widely distributed participants, seated at their desks, to hold real-time conferences by interchanging information through video, voice, and multimedia documents (Watabe et al., 1990).

While multipoint systems such as MERMAID focus on specialized architecture for real-time conferences, other systems like XGSP (XML based General Session Protocol) are based on Web services technology for creating and controlling videoconferences. Using web-services framework, researchers developed the prototype system, Global Multimedia Collaboration System (Global-MMCS; Watabe et al., 1990). The Global MMCS integrates various services including videoconferencing, instant messaging and streaming, and supports multiple videoconferencing technologies and heterogeneous collaboration environments.

Multipoint control units. The next system, Multipoint Control Units, is a central server used to coordinate and distribute video and audio streams amongst multiple participants in a video conference (Willebeek-LeMair, Kandlur, & Shae, 1994). There are three methods for video bit-rate reduction. In the most straightforward method, the input video bitstream is decoded to the pixel domain, and the decoded video signal is re-encoded at the desired output bit rate. In addition, the processed picture quality is improved by processing skipped macro blocks and applying frequency-weighted thresholding.

Integrated Service Digital Network. The Integrated Service Digital Network (ISDN) is part of the work carried out by the European collaborative project Multipoint Interactive Audiovisual communication (MIAC) and Multipoint Interactive Audiovisual System (MIAS; Clark, 1992). In the late 1960s, the audio-conference used the telephone network to provide audio together. In the 1980s, the new system allowed users to draw interactively on the face of a television screen by means of the light pen (Clark, 1992). Video conference, which is the newest technology, has been available for business and education for the last twenty years.

Access Grid. The Access Grid (AG) technology was developed by the Futures Laboratory at Argonne National Laboratory and is deployed by the National Center for Supercomputing Applications (NCSA) PACI Alliance (Access Grid Introduction, n.d.,
para. 1). The AG is a cutting-edge virtual audio/video videoconferencing and audio/video collaboration system that aims to create a real-time communication among multiple people from geographically separate locations as if they are engaged in the same room (Childers, 2000, para. 1).

"The Access Grid (AG) is the ensemble of resources that can be used to support human interaction across the grid. It consists of multimedia display, presentation and interactions environments, interfaces to grid middleware, interfaces to visualization environments. The Access Grid will support large-scale distributed meetings, collaborative work sessions, seminars, lectures, tutorials and training. The Access Grid design point is group to group communication (thus differentiating it from desktop to desktop based tools that focus on individual communication). The Access Grid environment must enable both formal and informal group interactions. Large-format displays integrated with intelligent or active meeting rooms are a central feature of the Access Grid nodes. Access Grid nodes are "designed spaces" that explicitly contain the high-end audio and visual technology needed to provide a high-quality compelling user experience." (Access Grid, n.d., para. 1)

In other words, the AG environment is very interactive, and can possibly improve the participants’ experiences by providing the participants an increased sense of social presence, supporting natural human interactions, eliminating the distance problems, and allowing for complex multisite visualization environments (Argonne National Laboratory, n.d., para. 1).

**Purpose of this Research**

While others have researched user effectiveness of multi-point systems, the evaluation of AG Technology has lagged behind in its research of user effectiveness. There are so few studies conducted on the use of the AG that basic questions have yet to be answered. The remainder of this chapter explores several ways AG technologies can be used for educational purposes. In our research, we explored the efficacy of AG technologies for collaborations and dialogue. This evaluation was comprised of two phases regarding AG use: evaluation as a tool for ANVs and as a tool for engaging educators in dialogue. This chapter does not discuss details related to the dialogue data, but rather describe the technical aspects of using the AG as a collaborative ubiquitous technology for use in education.

**General Use of the Access Grid**

To fully appreciate the AG and its use, it is first important to understand all of the technical aspects that constitute the AG. The AG is made up of connected “nodes” throughout the United States and the world, and as of 2005 number over 500 (Access Grid, 2007, para 2). In addition, an interactive map of worldwide AG nodes is available at [http://www.accessgrid.org/map](http://www.accessgrid.org/map). Within each node there are audio and video systems, as well as a high-performance network, hardware, and essential software. The following sections will provide highlight each of these technological aspects of the AG and how
they fit together to become the AG. We will then move on and discuss the different applications of the AG, and finally our research using the AG.

**AG Technology**

**AG node.** An AG Node (AGN) is a collection of hardware and software located in a room that uses the AG technology and permits electronic communications to other AGNs (Custom Fit INC, 2001, para 1). While in use, each AGN has staff present to assist with set-up and any technical difficulties. The number of staff varies and depends on the size of the events; usually, the number of staff is larger at a formal event than at an informal event. Specifically, “The staffs are responsible for making audio adjustments, monitoring the network, adjusting camera angles, monitoring and adjusting display windows, managing microphones, and running collaborative tools” (Disz, 2001, para 1).

**Audio and video system.** The audio system for each node needs to be high in quality, so participants in any size meetings can be heard by all participants in the event. Since the AG is on a high-speed network, the video quality is high as well and jerky motion is reduced (Introduction to Access Grids, n.d., para 1). What this means is that people at different locations can still interact with each other as if they are meeting each other face to face.

Unlike other commercial videoconferencing tools, the AG screen display is the size of a wall. This allows local and remote participants in an AG event to view each other simultaneously, as well as viewing and manipulating other visuals. Also, because the screen display is so large, it improves communications. The large screen display makes transmitting nonverbal information easier. Examples of nonverbal information include participants’ facial expressions and gestures. Nonverbal cues like these are very important for communication. As a consequence, participants appear to be engaged, as though face to face, and the event is much more interactive. For example, scientists and engineers at multiple sites can share their scientific findings, conduct experiments, and manipulate the same data sets and visual simulations, while talking back and forth.

**High-performance networks.** An AGN must have multicast-enabled networks. “Multicast-enabled networks allow one single output stream to branch off to multiple locations and to be sent only to the locations requesting the service” (Disz, 2001, para. 1). As a consequence, multicasting reduces bandwidth and makes sure that all participants receive the same information at relatively the same time. The minimum bandwidth is about 100 Mbit (Introduction to Access Grids, n.d.).

**Hardware.** The hardware for an AGN is off the shelf and available at a reasonable cost, which allows for people to set up their own AGN. The hardware includes four computers, cameras, projectors, speakers, and echo cancellation equipment (Welcome to the Access Grid at NCSA, n.d.). “The echo cancellation equipment is an important feature in producing high audio quality” (Introduction to Access Grids, n.d., para 1). The computers are run on Windows and Linux and are used for video and audio capture, camera control, speaker volume control, and displays (Welcome to the Access Grid at NCSA, n.d.).

**Software.** The AGN also needs open source software such as Videoconferencing Tool (Vic), Robust Audio Tool (RAT), Distributed PowerPoint (DPPT), Virtual Network computing (VNC), and Chromium-vic (VTK/VIC) (3). The Vic is multicast-based. The Display Computer runs on this, along with virtual venues software and Distributed
PowerPoint (DPPT). The virtual venues software provides a virtual space for participants in an AG event, which means that participants in an AG event have space on the web where they meet, the equivalent of a physical room for a meeting. RAT has high audio quality.

DPPT allows a presenter to control a PowerPoint slide show on multiple sites from a single machine. Thus, each participant of the same AG event has a copy of the presenter’s PowerPoint slides, which is available for all groups that interact over the AG. The VNC displays is a system for application sharing, that is, a participant can view an application not only on the machine from where it is running, but also from anywhere on the Internet. The use of VTK/VIC improves visualization when using the AG (Argonne National Laboratory, n.d.).

**Putting it all together.** Below is a figure taken from “Introduction to Access Grids” (n.d.), and illustrate how the different technological parts of the AGN work together.

![AGN Flow Chart](image)

**Figure 1. AGN Flow Chart**

Figure 1 above helps to illustrate how the Display Computer is responsible for the projectors; the Video Capture Computer is responsible for the cameras; the Audio Capture Computer and Control Computer are both responsible for the echo cancellation equipment, speakers, and microphones.

**Applications of the AG**

The AG can be used for formal and informal events, collaborative work sessions, seminars and conferences, lectures, and training sessions. An AG event can be as simple as a meeting with two people at two different locations and as complex as a large
conference with many participants from as many as 90 or more different sites. “Other than spoken and written words, other means of communication also include visualizations, computer-aided searching, shared software, image processing, virtual reality experiences, telepresence experiments, and remote instrument operation” (Welcome to the Access Grid at NCSA, n.d., p. 1). As stated earlier, the AG supports all of these means of communication.

The following pictures are taken from “Introduction to Access Grids” (n.d.), of the AGN at the University of Manchester.

![Figure 2. An AG Meeting](image1)

Figure 2 shows people participating in remote meetings. The screen display is very large so participants can view other participants at multiple sites.

![Figure 3. Collaborative Visualization and AG](image2)

Figure 3 illustrates how AG enables participants to view multisite visualizations (i.e., screens).
For events where some visuals are necessary to better understand a topic, not only is a large screen display indispensable, but so too is the quality of the audio/video systems. For small group or individuals, they can access the AG using the “Personal Interface to the Access Grid (PIG)” (see Figure 4 below).

![Figure 4. Personal Interface to the Access Grid](image)

The AG functionality is reduced with the PIG, but so is the required equipment. As illustrated in Figure 4, the display screen is much smaller than the normal AGN and only one computer and three monitors are needed.

The AG plays an increasingly important role in the field of education. As mentioned before, the AG environment is interactive and it encourages active teaching and active learning. This research utilized the use of an animated narrative vignette (ANV) as the stepping off point for the participants’ discussion while engaged in discussion. The focus of this research is the actual application of the AG and the students’ reactions to using the AG.

Methods

Participants

There were two universities participating in this project; University of Illinois at Urbana-Champaign (UIUC) and East Carolina University (ECU). Each university had two groups of students who participated in the project. UIUC had a total of eight participants; five participants in group one and three participants in group two (see Table 1 below). ECU had twelve participants total; six participants in each group (see Table 2 below).

The eight students at UIUC were all Caucasian females. These eight students included seven undergraduate students and one master student. Table 1 shows information for the participants at UIUC.

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caucasian female, Junior in music major.</td>
<td>Caucasian female, Junior in Ag education major.</td>
</tr>
<tr>
<td>Caucasian female, Junior in elementary major.</td>
<td>Caucasian female, a senior with a major in finance major.</td>
</tr>
<tr>
<td>Caucasian female, junior in</td>
<td>Caucasian female, a</td>
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</tbody>
</table>
Table 1. Characteristics of UIUC Participants

For each UIUC group there were also additional participants that included Dr. Sharon Tettegah (ST, facilitator), Edie (Ed, AG coordinator), George (Ge, technical assistance), Joycelyn (JL, dialogue facilitator), and Grant (Gr, research assistant).

The twelve students at ECU included five males and seven females (See Table 2). These twelve students were a combination of first-third year doctoral students, and no other demographics were available. Table 2 explains the information for the ECU participants.

Table 2. Characteristics of ECU Participants

For each ECU group, Cheryl, a facilitator, was also present during each session.

Materials

The materials for this project included laptops with internet access for each of the participants, an AGN at UIUC and ECU, and the (ANV). An example of how the AGN was set up is shown below in Figure 5.
The typical room has a capacity of about 30 participants and has a large-scale display with three projectors. The ANV used for this research focused on student teacher interactions within an educational context.

**Procedures**

The primary investigator, Dr. Sharon Tettegah, talked about the Access Grid project to a co-director at the National Center for Supercomputing Applications (NCSA). The co-director, Edee, at NCSA suggested a couple possibilities about how to find other university sites willing to participate in this project. From this conversation, the primary investigator decided to send out the research plan to several universities and asked if any were interested in participating. One of the universities, East Carolina University, replied and agreed to participate in the project.

The primary investigator sent an e-mail out in January 2004 to all the doctoral students in the educational leadership-higher education concentration at East Carolina University describing the study. The participants had a chance to win a laptop computer and two gift certificates as incentives for participating in this project. Twelve of the students contacted the researcher and agreed to participate in the study. The twelve participants were divided into two groups and each group had six participants.

The primary investigator also posted the project on the bulletin board on the human subject pool at UIUC. There were eight students who signed up for participation on the project. The eight participants were also divided into two groups. There were five participants in group one and three participants in group two.

The researcher set up the Access Grid technology and met UIUC participants at the South Research Park (SRP) on the University of Illinois-Urbana-Champaign campus. Each group (group 1 and 2) from UIUC and ECU met at the same time (i.e., the UIUC students and ECU students were hundreds of miles away, but they were able to talk and see each other using Access Grid technology).

Both groups (group 1 & group 2) from UIUC and ECU had the same procedures, even though they met at different times. When the students sat down and were ready on both sites, the researcher introduced the project and procedure to all the participants. The participants from both sites were also asked to briefly identify themselves at the beginning of the project. Since each student had a laptop computer in front of her/him, they had a chance to browse around and explore the ICCTP website for few minutes. The
researcher also gave participants the directions on how to find the vignette link, and how to register for the vignette page. All participants were asked to use a pseudonym and password to log into the vignette animation. Using pseudonyms kept participants’ identity confidential in this research.

The students observed the ANV simultaneously on both sites. There were a few technical difficulties that happened during registration and the observation of the ANV. However, all students were able to see the ANV and responded to the vignette questions at the end. Participants were also asked to fill out a site survey and paper survey after they responded to the vignette questions.

When all participants finished the surveys, the researcher and all participants discussed their thoughts and perspectives about the vignette story, as well as what they thought about the use of the AG (data discussed in this chapter). The participants from the two different sites were able to see each other with a wall size screen and were able to engage in a dialogue at same time by using the video conference system.

Results

Participants’ Reactions

Overall, the participants seem to split pretty evenly between those who enjoyed using the AG and those who didn’t, with two participants expressing both their enjoyment and frustrations with the AG technology.

“I thought it was pretty cool, uh, I don’t know it, it was a little hard to, at some points to uh, understand what you guys (ECU participants) were saying, but I thought it was neat that, you know, like, we can communicate with people in a totally different room and talk about this stuff.” – UIUC participant

“Except for the breaking up it has been great” – ECU participant

As you can see from the above quotes, these participants recognized both the benefits of using the AG, while also discussing at least one of the pitfalls (technical difficulties). A few of the participants did not enjoy the AG. Those who did not enjoy the AG stressed that they preferred true face-to-face meetings with people, and that a face-to-face meeting would have encouraged more discussion.

“I’ve actually had a distance class in this kind of format and the only thing that’s difficult about it is it’s hard to be interactive with people on the other side. Limits what you can do.” – UIUC participant

“I would rather be face to face. I prefer that. It is a unique technology advancement, but I would rather be face to face” – ECU participant

“I really didn’t like it (smiled and laughed nervously). I feel like, uh, if I was just like talking with a group of people here we might have gone a little further and it’s really hard, you know, with people breaking up, and you know, I’m looking into a camera when I’m talking and it’s just, and I didn’t like it really!” – UIUC participant

Two of the participants noted a general dislike of the technology for this type of use and another participant noted that it wasn’t comfortable for her and that the technical difficulties didn’t help to ease her discomfort.
On the other side, there were participants who indicated a lot of enthusiasm and enjoyment with using the AG.

“Yeah, I think it’s a very interesting way to discuss something different, I’ve never done it before, so I think that, yeah, it was really cool.” – UIUC participant

“I wasn’t expecting it at all, so it was something, something new and interesting” – UIUC participant

“I really enjoyed it! I think it’s neat that you can see people from like, how, I don’t know how far away, like half the United States away.” – UIUC participant

All of the participants who had positive reactions to the AG seemed to find the “the technology to be important and intriguing” (or is the word “), as did some who also preferred face to face meetings. Most thought the AG provided an advantage of being able to see and speak with people from across the US and the world.

Technical Issues

The AG collaboration was a successful project; however, we found several problems associated with using the tool. During study and workshop over the AG the dialogue had to be adapted for the setting. The participants were not able to sit facing each other in a circle, and participants often had to raise their hands and be addressed before beginning to speak, rather than just being able to chime in when they wanted. A time-delay occurred that inhibited each group’s communication. For example, sometimes when participants spoke to each other there had to be a sufficient amount of space between them so that the video could capture their face. It was very distracting) for the participants when they sat in a circle because one participant could block the view of another participant because of the location of the cameras. Participants were spaced apart, facing forward, and not sitting directly behind or in front of someone else so that everyone could be seen. In addition, there were multiple problems hearing the speakers (as discussed by some of the participants above), and participants often had to wave their hands while speaking so people on the other side could identify who was talking.

When playing the vignettes over the access grid for both groups to hear simultaneously, there were extended pauses between vignette characters, and the study facilitators commented that the speech seemed to be delayed. Several participants also had trouble turning up the volume on their computers to hear the vignettes. Once the volume was up, however, and all vignettes were playing, it was difficult for participants to hear them due to the noise of the other computers. In addition, the microphones had to be muted in order to reduce the sound coming through to the other side (i.e., UIUC’s microphones had to be muted so that ECU could hear their vignettes and vice versa). Once the second group of participants were finished listening to the vignettes, they were instructed to shut down their computers. Several computers from both sides could be heard shutting down while other participants were working on their surveys, which appeared to be distracting.

Technical problems unrelated to the AG included that required computer software (Quick Time) was not available, so the “ask the professional” portion of the ICCTP website could not be viewed. Two ECU participants had a difficult time registering on the computer because they did not include their full e-mail addresses (including the @
symbol), and at one WE experienced other technical difficulties unrelated to the AG. Edie, the AG coordinator’s computer froze up as she was trying to register. In addition, on the ECU side, there was a problem with the space in that the room in which the dialogue was held adjoined to another room and people in the two rooms could hear each other.

**Conclusion**

The purpose of the chapter was to explore the use of the AG for a specific educational purpose. We tested the ability of the AG to stream ANVs. Exploring and examining an educational application of using the AG provided us with a baseline for using the AG to stream and engage in a dialogue across the AG for multiple viewers. After an ANV was shown, participants discussed and reflected on the event which took place in the vignette. In a situation like this, mere verbal communications could not capture participants’ reactions adequately, yet with the AG technology, the participants’ could communicate using verbal and nonverbal forms. Not only was information shown and shared, but also facial expressions were transmitted and responded to in turn. In the context of social communication, this is especially vital and illustrates how well suited AG technology is for this type of research. However, it would be important to address the technical and logical issues identified in this study prior to using this technology for future research. For example, it would be important to make sure that all the participants at one site could hear and see the participants at the other site and were informed of the time-delay between sites. Also, the location of the AG would need to be considered.

In this study, ECU’s AG was located in a large open room with multiple classrooms. All of these technical and logical issues could be minimized and possibly eliminated while making this technology appropriate for engaging in collaborations and dialogue. The appropriate space should be identified before attempting to engage any type of open discussion over the AG.

**Readings and References**


Cafes function very well as informal public gathering places. One can enjoy the company of others or be quite comfortable alone. And they are great places to sit and watch people. The online world also functions as a public gathering place. As in the cafe, conversation is one of the primary activities - but with some striking differences. Online, conversing with strangers is quite common and there are few barriers to such interactions, while in the real world such encounters are less common and occur couched in complex social rituals. In the online world, one is fundamentally alone: although there are many others virtually present, one's sense of their presence is minimal. In the real world cafe, the number of people is fewer, but their presence is far greater.

These two worlds come together in the ChitChatClub. It is a real cafe, with real tables, real coffee and pastries. Yet the customers seated round the tables may be present physically or virtually - some of the chairs are ordinary seats, accommodating the human form; others are seats for avatars, equipped with monitors and network connections. While this is a ubiquitous computing environment, great care has been taken to make the interaction between the real and virtual seamless, and to mitigate the appearance of the traditional computer display and interface.

In this chapter, through an examination of the ChitChatClub, we explore the physical embodiment of virtual presence.
Figure 1. (top right) Artistic rendering of the *ChitChatClub*. A cafe space is populated by people who walked into the cafe, and who remotely connected to it through the conduit of the “avatar” seats at the tables.

(bottom) Early rendering of an “avatar” seat.
The Cafe Scenario

ChitChatClub is an experiment in bringing people together in a mixed physical and virtual environment. Online chatrooms and real world cafes are both venues for social interaction, but with significant differences, e.g. the participants' knowledge of each other's expressions and identity and the more governing introductions, turn-taking, etc. Our goal is to create, thru careful design of the physical environment and computer interface, a place that gracefully combines these two cultures (see Figure 1); the analysis of how well this space actually functions will further our understanding of social interaction, both online and in person.

The First ChitChatClub Installation

Physical Avatar
The physical “avatar” seat was designed to be of human scale. The idea communicate with an interface that was at the same head level as opposed to a monitor with similar proxemic codes as sitting face to face. We designed the “avatar” seat to be anthropomorphic to a degree, but not so anthropomorphic that one would expect human movement and human expression.
The body frame is meant resemble a relaxed figure of human proportion. The head resting on the frame has some curvature, and is painted white so that it makes a good projection surface. A projector hangs in a wire basket beneath the crossed “hands” of the “avatar seat”, or in this case, Slim. This projector is aligned to project moving faces onto Slim’s head. Above Slim’s the crossed “hands”, rests a camera facing away from Slim. This camera captures video of Slim’s companions in the physical ChitChatClub.
The Local Space

Figure 5. Two people sitting on each side of Slim, our “avatar” seat.

The local space of the ChitChatClub is a cafe setting. The “avatar” seat, “sits” at a table, and people entering the cafe, may choose to sit near him or her. Figure 5, shows a picture of one table in a ChitChatClub.

The Remote Interface
The online site is a portal for the remote visitors to enter the ChitChatClub. Using the ChitChatClub website, the remote cafe attendees can create an appearance for their visit, they can choose where to sit, and they can converse with the cafe’s local participants using either audio or text. While they are conversing with the visitors of the physical cafe, they see an abstracted video representation of their table companions from the point of view of the avatar seat they occupy. Although the remote visitors may type as well as speak to converse, they always hear what the cafe’s physical participants are saying.

![Avatar Faces](image)

**Figure 6.** Alternate view of face-creating interface with some claymation components.

**Getting Started**

When an online participant first encounters the online ChitChatClub interface, they are presented with an interface for creating an avatar face for their respective avatar seat (see Figure 7). Using this interface, the visitor can customize the appearance of their avatar seat’s face. They may choose face shape, eyes, lips, as well as the color of each feature from a selection of handrawn, claymation, and cartoon facial components. The avatar faces resemble cut-out animations.
After the visitor creates their appearance, they are ready to proceed to the ChitChatClub entrance. Here they see a graphical birds-eye view of the layout of the physical space (see Figure 7). This representation shows the location of the tables, chairs, and avatar seat. It also shows which seats - regular and avatar - are occupied. The participant uses this image to select which avatar chair to occupy.

The Communication Interface
Once a seat is selected, a two-way audio and video connection is established. In the cafe, the remote participant’s avatar face appears in the chosen chair. At the remote location, the participant sees a live, processed image of the cafe as seen from that chair (see Figure 9) and can hear, see, and participate in the conversation at that table.

Figure 7. (a) The face selection interface. The user can cycle through different eyes, lips, and face color by clicking on the representative icons on the right. (b) Birds-eye view of the cafe. Blue represents walk-in visitors and red represents kiosk visitors respectively. A vacant seat is depicted by an outlined circle; an occupied seat is depicted by an opaque circle.

Figure 8. Communication interface with different orientation.
While connected, remote visitors can communicate by talking or by typing and can momentarily change their avatar’s expression to appear happy, bored, disgusted, sad, or angry. Conversation from the cafe to the online participant is still received in the form of audio and processed video.

This interface was ultimately flawed. The remote users would spend a large portion of their time selecting facial animations; this deterred from the conversation. They also continued to click on the facial expressions so as not to appear inattentive. Users also wanted to direct the gaze of their avatar themselves as opposed to negotiating with the visitors to the physical cafe for rotation of gaze. We concluded that for these reasons, we had to make facial expression selection easier and effort-free, and allow the remote user to see how they appear at the physical cafe end.

**Figure 9.** The remote interface. The top shows a live video feed of the physical space. Below the user can choose from five expressions. The physical avatar face animates to that expression and then back to neutral.
The Second ChitChatClub Installation

*Physical Avatar*
We began to design a new “avatar” seat to complement the needs of our new proposed remote interface. Allowing the remote user to control their gaze into the space was a priority. The new seat, therefore, would require a redesign with a motor.
The new chair would also possess an anthropomorphic form, yet would not be a human sculpture. The final design and implementation of the second “avatar” seat, Orlando is shown below in Figure 12.

**Figure 11.** Building the new chair.
The Remote Interface
Entering the virtual component of the cafe is the same as in the previous version. What has changed in the second version is the addition of a set of facial components, the communication interface, and the “avatar” seat.

The Communication Interface
In the new remote communication interface, the remote participant could view the expression that was being projected onto their avatar seat head and control the motorized gaze of their avatar seat (see Figure 13). Novel to this interface was a new, comprehensive expression palette in the form of a wheel.

Expression Wheel
The expression wheel is designed to be a simple, intuitive interface for performing facial expressions. Facial expressions composed of componential elements (Smith 1997) such as the lowering of eyebrows and the raising of lip corners are mapped in smooth transitions around the circle clockwise. (see Figure 14). Higher intensities of these expressions are at the perimeter of the circle and blend to more neutral expressions towards the center of the circle. To make it easier on the user, there was no clicking involved. One simply had to mouse over, the area of the expression.

Figure 12. Orlando. The robotic “avatar” seat.
Even with this new continuous wheel, users continued to focus on the expressions and not on the conversation. To shift the attention to the interaction while maintaining expression cues during the conversation, we decided to abstract the representation of the expression wheel and make the expression selection somewhat autonomous.
We do this by tracking the pitch of the remote user in real-time and using simple heuristics to alter facial expression. One example of this is the correlation of rise in pitch to rise in eyebrows. Although, the expression selection is semi-autonomous, the user always has the ability to override the system and select their own expression independently.

**Figure 15.** Abstracted continuous emotion wheel. This expression wheel maintains the continuum of the previous wheel and also allows for a level of automation in expression selection.

**Figure 16.** The *ChiChatClub* communication interface. This implementation incorporates the abstracted expression wheel while maintaining gaze control and remote expression visibility.
The abstracted expression wheel allowed the remote user to focus more of their attention on the conversation and less on moving the mouse. There was, however, a trade-off in the expressiveness of the faces. With the automated expression selection, we were cautious not to deduce a false expression. Hence, the arc of the expressions did not always reach the extremes. In retrospect, it was the extreme, cartoon-like animations that provided more of a catalyst for interaction then the subdued ones.
Figure 17. Expression projections on avatar seats. (left column) *Slim* expressions. (from top to bottom) happy, bored, angry, “duh”, sad. (right column) selected *Orlando* expressions. (from top to bottom) happy, sleepy, angry, disgusted, surprised.
Scale in ChitChatClub

ChitChatClub was designed through several iterations. Care was taken to make the avatar seats human scale. If the seat is bigger and looks down on the person, it is intimidating; if it is much smaller, it is often ignored. This way, the remote participant occupied a similar space as the physical participants.

The seat was made to look anthropomorphic. There was a head, a seated body and arms. We did not want it to look so human that participants would expect human attributes, but we also wanted it to be accepted as an interesting seated visitor. The second avatar seat was motorized so the remote user could direct the gaze. This offered more control to the remote user and a focus for attention to the local users at the physical ChitChatClub.

Conclusions

Physicality and human-scale was the central social catalyst of ChitChatClub. The physicality makes for interaction far different from what happens while staring at a computer screen. In contrast to the Hydra system pictured in Figure 18, the human-scale in ChitChatClub provides for gestural behaviors at eye-level and not to several chess-piece-like screens. The similarity in scale blends the physical and virtual worlds together to emphasize togetherness versus remoteness.

![Figure 18. The Hydra four-way teleconferencing system.](image)

A final note on ChitChatClub: Although the installation emphasizes togetherness, there is an asymmetry in the public and the private. The local physical ChitChatClub occupants perceive more of the social catalysts and the physicality, although they only see an abstracted representation of the remote cafe-goer. In contrast, the remote user sees a fuller view of the participants albeit at a smaller scale and in a physically remote setting.

Readings and References


Chapter 16: Administrative Implications of Ubiquitous Learning

Faye L. Lesht

My interest in ubiquitous learning focuses primarily on the interrelationship between a growing interest in effective uses of educational technology online and on campus and corresponding administrative practices. While pedagogy remains at the core of the educational process in American higher education, administrative processes significantly influence it (Katz, et. al., 1998; Johnstone, et.al., 2007). To that end, the focus of this chapter is on the question: What are we learning about the types of administrative supports that are necessary to benefit faculty and students in the realm of ubiquitous learning?

The focus of this chapter is on online education. Online education is one form of distance education—or a separation for the pedagogical experience between instructor and student in time and/or space. The field of distance education emerged in the 1800s with the establishment of instruction by mail developed at the University of Chicago; as new forms of media emerged in our society such as radio, television, and computers, colleges and universities have used these media to extend academic resources to those near and far (McIsaac & Gunawardena, 1996). While distance education has enhanced access to high quality educational opportunities on the part of those unable to return to a college campus due to circumstances, today the definition includes an array of situations. Among these are: Online education limited to the non-residential student; online education that includes residential and non-residential students; online education for the residential student; video conferencing, tele-conferencing, pod casts, and combinations of instructional delivery methods, to name a few. There remain courses offered that use video conferencing, for instance, as a form of distance education delivery without internet as part of the instructional model.

Consequently, ubiquitous learning means more choices for students and for faculty than in the past. This choice is becoming recognized nationally. For example, in 2004 and 2006 when asked for a report of distance education student enrollments for a US News and World Reports survey it was necessary to contact US News in order to clarify definitions of the term “online student.” As access to online education for residential and non-residential students grows, it may enable higher education to recreate itself (McGrath, 2004). Yet, obtaining accurate data on who is to be counted as online for reports and who is not is a challenge administratively, given the relative newness of the venture.

Similarly, as more on campus students begin to take advantage of online courses, it becomes increasingly important to examine and keep in mind similarities and differences between residential and non-residential students engaged in online education in order to meet the needs of the learners in ways that are appropriate, effective, and affordable. This
is a complicated matter; one that will require additional formal study. At the same time, it is important to keep a perspective on ubiquitous learning. For example, Academic Outreach, Office of Continuing Education at Illinois, has been in existence for over 70 years and has long been devoted to serving both students at a distance and delivering education using distance education technologies. This includes guided individual study or self-paced instruction in print and online as well as administering semester-based offerings (including full degree programs) using a variety of instructional delivery tools. Academic Outreach was among the first units on campus to encourage the use of technology in instruction, experimenting with videotapes and a variety of audio and visual enhanced forms of instructional delivery as tools became available, affordable, and accessible to students as well as faculty.

Today, the University of Illinois tends to prefer a common learning management system (although the particular one will vary by campus) whereas 10 years ago there was more diversity and experimentation. Academic Outreach had a web technologies group that programmed from “scratch” templates that would be customized for academic units interested in using the web for instruction. There remains some variety on the Urbana campus, although not as much as when the web was getting started. Academic Outreach itself continues to transform as a result of ubiquitous learning. For example, there is a temptation to use technology for campus instruction and perhaps neglect the ways that educational tools today can further enhance innovation and access for residential and non-residential students. This is often due to time constraints.

As technologies become more ubiquitous in nature, a challenge and an opportunity will be using resources in new ways order to reach adult part-time students unable to relocate to campus—ways that further enhance the curriculum as well as access to it. Academic Outreach has found Elluminate—one form of software that enables faculty and students and class members to interact in real time during class for instance—to be an effective way to pace courses. New products are released routinely by companies and organizations and thus it becomes important to be able to scrutinize educational technologies so that investments are made in those that will be most useful over a period of time.

The following two cases are composites drawn from faculty, administrative, and student experience, including through empirical and survey data. Case 1 provides examples of factors contributing to student success and satisfaction in a ubiquitous learning environment and Case 2 provides similar examples from the faculty perspective.

**Case in Point 1: Returning to college after many years**

Imagine you are employed full-time with a family to support. You decide that while you like what you are doing, further formal education would be beneficial. The last time you enrolled in a college course was in the 1980s. You consider your options and find a program of interest at your alma mater—a public, research oriented institution—and the program is available in a number of delivery formats including online with limited
campus visits required. You are intrigued by the flexibility of online education and also have concerns. At the same time, given your responsibilities, a purely residential experience is not viable. You have the qualifications to pursue your academic interests so you decide to explore the online program further prior to enrolling. Prior to contacting an advisor at the institution you prepare a few questions:

- How do I know my learning style is suitable to online education?
- How accessible are faculty?
- What services—especially advising, technical and student support services—are available to me on a timely basis?
- Will I be able to afford this opportunity?

The faculty advisor with whom you speak has a wealth of experience from which to draw to respond to your questions. You learn the following:

- Flexibility exists for you to enroll in an online course to “get your feet wet” prior to applying for admission to the degree program.
- Assistance is a telephone call and/or an e-mail away.
- Services including technical support; resource materials such as textbooks and reference materials; advising; and assistance navigating the system; are handled promptly, mainly through electronic media (e.g., e-mail, telephone, online discussion boards) by well-qualified staff.
- Financial assistance is available to degree-seeking students carrying the required minimum academic course load based on federal guidelines. At the same time, the program costs are competitive and effort is made to keep them affordable. This includes no travel requirements, no need to find or pay for parking, and limited to no time away from work and family.
- Some courses require a weekly synchronous (“real-time”) meeting with the instructor to review material, address questions, and to support a sense of community on the part of the students and the professor. Course expectations including attendance, participation, and assignments are high.

On considering this information, you decide to enroll. As you proceed through the course you enjoy the ability to access material at any time, while realizing you need to set aside time for study as you would if you were attending this class on campus. At the same time, you find that the weekly synchronous sessions provide a way to stay focused. They are archived so you can refer back to them—an advantage over your previous experience years ago in school. Also, as the online format enables and requires text chatting, you find you are asking more questions, are interacting more with other students, and are more engaged with the instructor and the general experience than was the case years earlier on campus.

As the semester draws to a close in addition to the fine instruction you received you reflect on the supports that were particularly useful to your experience—an experience along with the instruction that encourages you to apply to the degree program.

While this case represents an ideal, it is based on survey data (Graduate College Committee on Extended Education and External Degrees, 2003, 2005, 2006), related literature (Cole, 2000; Haythornthwaite & Kazmer, 2004; Meyer, 2001), and
administrative experience in Academic Outreach. It points to critical administrative supports for online students at a distance including:

- **High quality faculty well prepared to teach online.** Appointment and mentoring by administrators of faculty who know the subject matter and are able to teach well using technology is a critical responsibility of administrators on campus and especially so for online courses. UIUC employs mainly full-time faculty to teach off-campus and online; part-time or adjunct faculty are used to teach courses in specialized subject matter areas. At the same time, faculty members need training with proper uses of technology. Academic Outreach and some departments have found it useful to provide technical support throughout the semester during synchronous sessions so faculty members are able to focus fully on the content. Also, etiquette online and lack of body language and physical cues are learned skills that can be facilitated by appropriate support.

- **Support services for faculty and for students.** Administrators must invest in the appropriate levels of support in order for online learning to be effective. This includes investing in technical staff that attends to faculty and students needs; advising; library services; and ways to facilitate online students navigating the institution. For many years, Academic Outreach’s registration system was a “side system” required to be used in lieu of the campus system. This provided a degree of flexibility; however the system needed to be aligned with the campus system for ease of processing including financial aid. The current enterprise system used by the University for registrations, billings, and human resources, allows all degree seeking students to register directly in a web-based system. However, Academic Outreach continues to register non-degree students into the system and due to demand recently developed its own non-credit registration system as a number of adults wish to enroll in credit courses on a not-for-credit basis for professional development.

- **Establishing a sense of community**—for some disciplines this is especially important. Administrators need to understand the value of maintaining manageable class sizes so faculty can manage well their online courses in addition to online chats and networking that can be integrated into the curriculum.

- **Flexibility and ease of access.** Convenience of online education is a main appeal of online courses for the adult, part-time students; administrators are in a position through ubiquitous learning opportunities to expand the portfolio of courses available online so that the distant student has more choice each term and throughout their program. An idea initiated in Academic Outreach was the notion of an “Idea Village”. This was to be a virtual interface to the campus for off-campus and online students; it would have given students access to the campus community in new ways. However, it was an idea “ahead of its time”—considered early in the development of online education and was not developed (K. Gustin, personal communication, July 6, 2007).
Responsiveness is key and requires that administrators allow faculty and staff ample time to address issues of online students/education. This includes investing in technical support during synchronous sessions when students can “whisper” to a technician and not disturb the class; examining administrative practices to promote a welcoming, albeit rigorous, learning environment. The internet itself provides a variety of ways to ensure responsiveness. A staff member of Academic Outreach notes, “An example of a concept born from the internet is Instant Messaging. It not only allows us to keep in touch with college, students, and family but does so almost instantaneously. And it’s available to practically anyone throughout the world!” (T. Suttle, personal communication, July 3, 2007).

As campus students juggle classes, activities, and work, they too are supplementing their residential experience with online courses. It is important to keep in mind that online students many miles and sometimes entire continents away from the institution are a different profile in terms of their needs than are residential students—even those in the same online course. Administrators are increasingly asked to examine ways in which student support services can remain flexible enough to be friendly toward the non-residential student, while remaining appropriate.

Case in Point 2: Teaching the same course online as on campus, faculty perspective

Now imagine you are the faculty member teaching the course in which the student in Case 1 enrolled. You have been teaching since the early 1980s and continue to teach on campus. However, over the past decade you have begun teaching online while you continue to teach on campus. Recently, you have experimented with uses of educational technology in the campus classroom as well with course sections that enable students at great distances as well as those in residence on campus to take the course simultaneously online. Some of this is at the urging of your department, some of it is due to the access your campus students have to technologies, and some of is due to your own interest.

You have found that while the online environment has its set of challenges, it has also enabled you to enhance your campus teaching and has benefits for you and your students. At the same time, you note there remain differences between the two environments. While you work diligently to ensure that the quality of instruction is the same regardless of delivery mode, you are aware of various administrative supports that facilitated your ability to deliver the course online affectively, along with related challenges. These include:

- Several years ago your entire department actively chose to engage in online education.
- The department head granted you, and your colleagues, a course reduction each time you prepared to teach an online course for the first time.
- The head assigned a faculty member to focus on the administrative aspects of the online enterprise of your department. Support from campus units such as the
Academic Outreach, CITES, the Library, assist you and colleagues in other departments.

- Each semester there are periodic discussions for all faculty members teaching online (including with part-time faculty teaching from a distance) as ways to further support your experience.
- Pedagogical growth and development is encouraged to transfer between online and on campus courses and you and all your colleagues actively engage in discussions that further your effectiveness as a scholar and educator.
- Your efforts in online education are recognized as part of the annual promotion and tenure process.

At the same time, there remain advantages to teaching on campus. For example, the other morning a newly illustrated book of relevance to both your campus and your online classes was in your mailbox and while you could easily share it with the campus class that very day, it would take more time to do so and involve at least assistance from technical staff if not also instructional designers to provide a similar experience to your online students (E. Hearne, personal communication, April 18, 2007). In fact, the online experience requires more team work among faculty, administrators, and technical support staff than does your campus class.

However, it is also the case that in the online course the students are more readily exposed to experts from across the country who periodically join synchronous sessions the same way you and the students do. You have also noticed that, just as our student in Case 1 noted, there seems to be more engagement in discussions on the part of the entire online class than there is in the campus classes you teach. Students seem freer to express themselves online than in the classroom and provided they follow standard rules of etiquette there tends to be more interaction. This leads to another phenomenon you have noticed—the need to schedule breaks or time away from the computer. An online class can be even more demanding than an on campus class so you learn the importance of creating boundaries since they do not necessarily exist as is typically the case with campus instruction.

As with Case 1, this is a composite. However, the scenario and the following summary are heavily based on faculty report and related literature (Graduate College Committee on Extended Education and External Degrees, 2003, 2005, 2006; Haythornthwaite & Kazmer, 2004; Lesht & Shaik, 2003; E. Hearne, personal communication, April 18, 2007).

Critical administrative factors facilitating online instruction for faculty include:

- Commitment on the part of the entire faculty for the effort. This includes consensus on the part of administrators and faculty that the endeavor is important and a good use of time.
- Assignment of a dedicated faculty administrator to coordinate the program. This lends credibility to the program and also ensures that faculty and students have appropriate support throughout the process.
- Technical support and training; more of a team emphasis in constructing the course online than on campus. Faculty need support during class time and they need to work with the technical team to help design, prepare, and revise materials throughout the duration of the course; use of appropriate technologies for the situation.

- Ability to interact with students in both synchronous and asynchronous modes. This also facilitates a sense of community. Academic Outreach uses Instant Messaging and, currently, Elluminate to facilitate synchronous communication. However, there has been an evolution over time of products that facilitate interaction between faculty and students and students and students before, during, and after class. Other examples include bulletin boards, telephone, and chat sessions.

- Recognition of the breadth of human resources required in order to make it possible for the faculty member to focus on the instruction with limited distractions and to be able to live a balanced life. For example, Academic Outreach has kept its “hand on the pulse” of educational technologies for many years. It has led the migration from the “Electronic Blackboard (developed by AT&T along with the University of Illinois), to Vis-à-vis (DOS and Windows based produced developed by Bell Canada), VOICE (voice over IP and content delivery integrated into one package developed by Thin ICE), to Elluminate (greatly enhanced version of the above) over the years. The division was one of the first on campus to use Microsoft NetMeeting over the internet during a videoconference” (T. Suttle, personal communications, July 3, 2007). In order to test, develop, and implement appropriate educational technologies, appropriate levels of resources need to be expended.

- Support services such as library, registration, textbook delivery, and related processes so the faculty member can focus primarily on the subject-matter. Academic Outreach, for example, has had to develop its own non-credit system for online course scheduling, registration, and tracking, similar to the Banner interface in order to serve well students who wish to pursue professional development opportunities on a non-credit basis. The division has also instituted a Service Center that facilitates scheduling, non-degree registrations, reports, and related processes to complement Banner’s capabilities for the off-campus/online non-residential student.

- Encouragement for balance. As text chatting and e-mail are relied upon heavily and may be more than double that of a campus course to make up for the lack of body language and in person contact (E. Hearne, personal communication, April 18, 2007), administrators can encourage faculty to find ways to take breaks.

Class size small enough for effective interaction and classroom management, working as a team with administrators, instructional design, and other faculty to create the best possible pedagogical experience, and learning to take breaks from the online environment on occasion all contribute to good online teaching experiences as does college support. The assignment of an academic administrator to oversee the program, and time for community building between faculty and students were also noted as ways that
administrators have facilitated online programs (E. Hearne, personal communication, April 18, 2007).

Towards an Agenda for Ubiquitous Learning

These case studies are examples of the opportunities and challenges inherent in online/ubiquitous learning. The focus of this chapter has been primarily on the student who is located a distance from the institution and does not have easy physical access to its resources. However, many of the administrative issues covered are pertinent regardless of setting. They point to the need to recognize that as faculty and students are able to engage in the pedagogical process in new ways that include “anytime/anywhere” learning using technology, administrative processes of the past must be reconsidered and renewed. As noted by L. C. Smith (personal communication, May 15, 2007), “those wishing to facilitate ubiquitous learning need to consider barriers that students may encounter and how to reduce or eliminate them. Many of those relate to administrative factors and require the active involvement of administrative units providing services for faculty and students.”

Administrators working closely with students in online degree programs often note that:

- policies and procedures in place for residential students who can pick and choose from a variety of courses at a time do not all work well for the online student who has limited choices and may have even more limited experience in the online environment.
- Economic expectations of online programs often differ from campus programs so policies and procedures need to be considered in light of such expectations. For example, at Illinois some academic online programs are expected to generate a level of tuition income in order to cover costs in ways that are not standard for residential programs—although those too need to be cost sensitive. At the same time, Academic Outreach has been asked by a number of online program administrators to examine both market pricing and the ability to control tuition waivers to facilitate program viability while continuing to serve students. Integrity of academic programs remains high even as special consideration is given to administrative supports required of the online student at a distance.
- The need for faculty to be able to take time for “breaks” and “balance” in their lives while remaining responsive to student questions and online course needs (Meyer, 2001; P. Wherry, personal communication, July 11, 2007.)

Further research related to distinctions between online and on campus students embracing ubiquitous learning in terms of administrative implications is warranted. Advocacy, support services, fiscal considerations, and administrative practices need special attention. Recognizing that there are administrative implications to ubiquitous learning is a start.

References and Readings


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PART C: Practices

Chapter 17: History: The Role of Technology in the Democratization of Learning

Orville Vernon Burton, James Onderdonk, Simon J. Appleford

The twenty-first century is witnessing a blurring of traditional divisions between the domains of learning, teaching, and research. This change has been spurred, to a large extent, by advances in information technology, and all that that term implies in hardware, software, new pedagogy, access, accessibility and distribution of data and its application. The collaborative promise of new technologies and the so-called semantic web have the potential to free information from the dark corners of archives and forgotten shelves of history and make it available to all citizens. The ubiquitous anytime, anywhere learning that the twenty-first century both proffers and demands implies that teachers and learners must take a much broader approach to scholarship, teaching, and learning; new technology helps us meet that challenge.

At the close of the agrarian age, it became obvious to a broad spectrum of the public that the educational system that had served that age well was inadequate for the dawning industrial era, which demanded a well-trained workforce. Led by states with large rural populations, educational systems were transformed to meet this demand – the chief enduring result being mandated universal secondary education. Unfortunately America’s schools have evolved into an excellent example of an autocratic rather than a democratic organization where a rule-bound culture is vetted by standardized testing well fitted to its requirements. Today, with a new world information order evolving, the educational structures of the industrial age are proving inadequate and inappropriate for the demands of the information age. Data, that is information, is the rich raw material for this age much as iron ore and coal was to an earlier one. The transformation of that data into knowledge, experience, and responsible action is a primary function of the learning processes and must be encouraged. It is imperative that the academy lead a sophisticated and complex response to the promise of information technology.

The social critic John Ralston Saul observed “Highly sophisticated elites are the easiest and least original thing a society can produce. The most difficult and the most valuable is a well-educated populace.”\(^4\) (Saul, 1994, p. 116) The ubiquitous learning empowered by technology must not widen the gap between those who have access to new information and tools and those who do not. Technology has the potential to become a tool of the elite and our goal must be to ensure the democratization of knowledge and education. It is of particular importance that colleges and universities and especially the land grant colleges, those public institutions labeled “Democracy’s Colleges” in the 19th Century, commit to expanding the community of learning.

Why should we be particularly concerned with the application of ubiquitous learning in the humanities? The humanities is the largest portion of the human

experience. It is an area where critical achievements and endeavors in digital applications are already underway, and many more exciting developments are possible.

What we value as a society is an evolving social compact, not an algorithm. Information technology should maximize these values. Many humanists seem reluctant to welcome information technology but the humanities and the arts are especially important to help reach the larger citizenry with information in ways that pure computer science has never been able to do.

We need humanities for an understanding of who we are and where we came from. Having that knowledge we can then presumably make better choices about where to go next. Humanists deal with interpretation and appreciation of human culture. The humanities are about the creation and interpretation of meaning. The humanities constitute our nation’s very identity, who we are, how we understand ourselves, and how we tell others, as well as the generations to come, who we are. As Mark Twain observed, good judgment comes from experience and experience comes from bad judgment. Diligence in the study of the humanities can reveal to us both the considered and the poor judgment of our predecessors and help us profit from it. The use of it in teaching can do the same in humanities education—carefully constructed it allows the learner to see how they learned differently than others.

How might the humanities use information technology then, in its broadest application, to democratize learning? Here at Illinois, the Illinois Center for Computing in Humanities, Arts, and Social Science developed RiverWeb in an attempt to address the needs of undergraduate education in support of inquiry-based learning. A dynamic multimedia archive of Mississippi River history and information, RiverWeb was created to meet the challenge of integrating information technology into the classroom by providing an interactive, web-based research and learning environment that engages the students and brings the humanities, arts, and social sciences to life. It is structured so that faculty can offer their students the assistance they need to identify a problem, create hypotheses, explore humanities, arts, and social science information from different sources, combine, classify, and analyze that data, work with others interactively, and present conclusions in a cogent and concise manner. These skills, which structure all intellectual inquiry, are fundamental to transforming data to knowledge and knowledge to action, forming the capstone of research. RiverWeb integrates these critical data resources into cohesive narrative stories that follow individuals and cases over time and are linked to other sources in a coherent manner. The hands-on, inquiry-based approach to teaching and learning is supported by giving students access to original documents and artifacts, enabling them to “do” research instead of simply reading about it, thereby contributing to their own sense of genuine discovery. By providing access to interesting, concise, and relevant primary materials for research projects, RiverWeb also provides a learning environment that can help prepare students to handle life in a society that is increasingly dependent on science and technology. And because RiverWeb is Web-based, it is accessible at any time.

Modern computer networks allow access to an incredible amount of data; yet, very few portals or websites have been explicitly structured for dissemination of relevant and distilled data for use in a teaching or research context. One of the problems with using general purpose search engines to hunt for this data is the sheer amount of potentially relevant information available. This growth of information makes it
increasingly harder for learners to identify and make use of the most appropriate and highest quality educational resources. While digital libraries and some existing portals help address these problems, RiverWeb already offers access and opportunity to explore such learning resources within developed and tested curriculum modules. RiverWeb provides a multimedia, multidimensional information workbench with a self-sustaining framework that facilitates access to and collaborative use of knowledge, tools, and data.

RiverWeb has a working prototype with a wealth of accumulated web-based knowledge as well as an effective delivery system. Project members have worked extensively in formal educational environments as well as with real-world interface design problems and web-based learning environment applications to determine the best possible methods of creating sites with appealing design, easy navigation, advanced data retrieval, on-line discussion forums, and effective use of search engines. A flexible and extensive Web-based architecture (also transferable to CD-ROM to accommodate educators with no or slow internet connections) provides anywhere, anytime access to engaging, high quality, on-line, multimedia resources, independent of network availability. RiverWeb interfaces empower students and others to “time-travel” through humanities, arts, and social science data while hyperlinks lead them to a wealth of information banks, including spatial data, video clips, sound clips, maps, photographs, and paintings, along with text. RiverWeb provides a systematic framework for integrating fragmented and scattered data mined from archives, museums, libraries, and courthouses; scientific journals, newspapers, photographs, city directories, statistical data, tax records, marriage licenses, military rosters, church records, maps, audio recordings, and other textual information provide students with a unique and exciting window into discovery. Natural curiosity drives student inquiry though computer searches while RiverWeb provides multiple pathways to exploring and understanding complex concepts and relationships between ideas in humanities, arts, social sciences, mathematics, and core content sciences.

RiverWeb’s goals are clearly in line with national benchmarks for student learning goals, as outlined by Project 2061. Goals focus on the need to enhance chronological thinking and comprehension, analysis, data interpretation, research, and decision-making – precisely those skills critical to public participation in a civil society. RiverWeb provides a scaffold for the cognitive development of these capabilities. Moreover, the resources assembled are especially sensitive to and inclusive of the influences of race, gender, class, and regionalism, influences that have been both divisive and enriching. The resources are designed for use by a large community including undergraduate students, faculty, scientists, and other interested people including local citizens.

The prototype of RiverWeb focuses on one stretch of the Mississippi River, the American Bottom Region of East St. Louis. Specific regional information is rich and locally relevant. Among RiverWeb archival materials, for instance, are vivid archeological additions from Illinois State Museum scientists, including their work on the Cahokia Mounds. Designated a World Heritage Site by the United Nations, Cahokia was the preeminent Native American community in the region between A.D. 800 and 1300. Its population, actively engaged in a far-flung trading network through which ideas and goods were exchanged in all directions, had its most profound effects on the area immediately surrounding the city and its mounds. Communities altered the physical
landscape—often to its detriment—through farming, deforestation, and development. The Illinois State Museum used a geomorphic analysis of Quaternary deposits, topographic features, and soil surveys to reconstruct the floodplain and its environment circa A.D. 1100, and then deployed contemporary measurements and historical and archaeological data to document existing mounds and reconstruct those destroyed long ago. All this information is available through RiverWeb.

The architecture of RiverWeb is built to be fully modular and extensible, allowing faculty to integrate new content in a timely, cost-effective manner. A set of interfaces designed with the needs of faculty in mind allows the instructor to explore, navigate, add, and design flexible new areas of the site without requiring any in-depth familiarity with the foundational technologies that make RiverWeb possible. A suite of easy “wizard software” provides both guidance and backend support. The technologies that drive RiverWeb are made transparent to the end user, which enables RiverWeb to be used by people in a variety of formal and informal educational settings.

RiverWeb is very much a work in progress, reflecting the nature of ubiquitous learning itself. Its structure has undergone regular reorganization and continual design modifications as different thematic overviews, navigational techniques, site hierarchies, and technological applications have been tested. It now has two principal modes of navigation: nonlinear and thematic. While some learners use RiverWeb in a nonlinear fashion, others desire more structure. The nonlinear mode of navigation allows multiple paths based on specific needs rather than upon an imposed structure. The thematic mode revolves around the interrelated core themes of Environment, Society, Economy, Technology, and Art. The interconnection of these themes is obvious, but as separate means of exploration and pedagogy, they serve as organizational tools and as hotspots for further investigation. Interpretive navigation also lends itself to integrating RiverWeb materials in educational environments through the development of related activities, lectures, and projects.

In an unanticipated development, RiverWeb has become a site for informal learning. Recently, RiverWeb received an e-mail from an individual who came across the site on the Web. The encounter triggered his own memories of the East St Louis area and he unearthed a series of 75 photographs he took in the mid-1970’s of the old National Stock Yards in St. Louis. He contacted RiverWeb to see if we would be interested in them and then sent them to the University for scanning and posting on the site. He also forwarded a reminiscence of his time working there which will also be posted.

In a similar vein, a local amateur historian and community activist in East St Louis retrieved historical documents relating to the city—literally rescuing them from a dumpster. The materials proved to be city directories and other documents relating to the development of East St Louis, some dating from the late 19th Century. He contacted the University to inquire if we would be interested in preserving the materials. East St. Louis figures prominently in RiverWeb and the city directories can be invaluable in showing population migrations, particularly as they relate to historical events in the city, such as the infamous race riots of 1917. It also developed that there are at least a dozen residents who are more than 100 years old and a related project may be to collect oral histories from them about their experiences in East St Louis.

A question that arises in the teaching of the humanities in general and in history in particular is the question of the value of teaching localized subjects. How, for instance, in
this day of transnationalism and globalism, can one justify teaching about, for example, Illinois history—let alone East St Louis—and how we can emphasize local community studies? The answer seems obvious. In the realm of ubiquitous learning, people everywhere on the globe are part of a linked community. There is a sense in which (as Charles Joyner has reminded us) all history is local history — someplace. All too often, scholars address history at what we think of as the national or transnational level without realizing that these “higher, broader” levels are in fact intellectual constructs rather than concrete realities. No history, properly understood, is merely local. Moreover, the difference between history as opposed to antiquarianism is that either explicitly or implicitly, history must be comparative. Tools such as RiverWeb allow students to work individually and as a class from our nation’s documentary record and determine for themselves where various forces of history interact. As John Dewey observed on the value of education “The individual who has an enlarged and quickened experience is one who should make for himself his own appraisal.” Ubiquitous learning is certainly one mechanism to enlarge and quicken experience.

In teaching any course, one effective strategy is to insist that students seek some agreement on definitions. History courses, for example, deal with meanings of freedom and liberty in the U.S. so it is important for students to see how definitions vary and how differences affect an argument. This leads to an awareness of how historians think, what historians do, what tools they use to interpret the past, and how interpretations change. In the basic survey course, especially if this is the only history course students will ever take, it is all the more important that students know that historians disagree over facts as well as interpretations. We are not doing students in the surveys of American History a service to assume that historiography is too complicated and that they need to know the facts before they understand differing interpretations. It is important to emphasize that all historians, including the authors of their textbooks, select facts to include and exclude others. How someone chose their facts tells us something. An easy assignment to get students thinking critically is to have them ask themselves if other groups (Native Americans, Hispanics, African Americans, Asian Americans, non Europeans) would have used the same facts or interpreted them the same ways. In other words, students should be challenged to imagine different voices telling the story. Ubiquitous learning, with its access to diverse sources can greatly enrich this process.

A final thought on ubiquitous learning must include the caveat that we do not really know when learning takes place. What we can do in a digital environment such as RiverWeb is to show users how others constructed their research or investigations. Thus students can graph the arc of their own investigation or research project and compare it to others who used RiverWeb. The best that we can say for certainty about learning in the classroom experience is that while hopefully it does occur there, we remain unsure. Certainly the growth of on-line programs of all types and the relatively recent development of life long learning and the myriad venues employed by those programs strongly implies that learning takes place in many different ways and in a multitude of places. Howard Gardner challenges us to consider multiple intelligences when designing curriculum and technology may make it possible for the learner to self develop such

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5 Charles Joyner, Down By the Riverside: A South Carolina Slave Community (Urbana: University of Illinois Press, 1984), xvi
curriculum. The marvelous tools that make ubiquitous learning possible seem to follow Toyota’s “just in time” supply chain management techniques for manufacturing. But we must be careful not to mistake data retrieval for real learning and on this score it may be helpful to recall William James’ observation of 1890:

Thus, we notice after exercising our muscles or our brain in a new way, that we can do so no longer at that time; but after a day or two of rest, when we resume the discipline, our increase in skill not seldom surprises us. I have often noticed this in learning a tune; and it has led a German author to say that we learn to swim during the winter and to skate during the summer.6

Thus, in somewhat whimsical fashion, James reminds us that the occurrence of true learning can rarely be fixed and that learning, while once potentially ubiquitous in time now appears to be potentially ubiquitous in both time and space.

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Chapter 18: Computer Science: Pen-enabled Computers in the Classroom

*Samuel Kamin*

**What ubiquity means**

Computers promote ubiquitous learning by making information available anywhere, anytime. Yet information is not enough: learning requires teaching, and teachers are not ubiquitous; they are scarce. The goal of using computers for learning can be expressed as an effort to make the teacher more available. Our research is aimed at using two technologies – pen-enabled computers (specifically, Tablet PCs) and computer networks – to make teachers ubiquitous in the classroom.

To understand this odd-sounding phrase, consider why one-on-one teaching is so effective (Cohen, Kulik & Kulik, 1982). In this mode, the teacher develops a keen sense of the student: what he knows, what he is capable of absorbing at any moment, how fast he can absorb it, and how best to present it. From the student’s point of view, the individual tutor is “ubiquitous” in the sense that the student never feels her absence: no sooner does a question come to the student’s mind than it is answered; no sooner does he learn one concept than he is presented with another.

By contrast, a teacher in a large class – such as one commonly finds in a university – is barely present to the student, even during a lecture. And his absence is keenly felt: questions go unasked; misconceptions go uncorrected; new subjects are introduced before old ones are mastered. Little wonder that most large university classes are poorly attended.

Being ubiquitous in the classroom means the teacher knows the student, not just in general, but right now. She can sense the student’s confusion, misunderstandings, lack of confidence, and disengagement, and counteract them. It is essential to the learning process that the student experience confusion and uncertainty, tries solving problems at the edge of his knowledge and abilities, and formulates questions based on these efforts. The importance of the teacher is in not letting these periods of uncertainty last longer than is helpful. Teaching is a dialectical process: The teacher explores the student’s understanding and provides instruction of a kind and at a pace appropriate to that student; the student attempts to perform as the teacher wishes, expressing, in word or deed, how well the teacher is succeeding; these expressions in turn inform the teacher’s next interaction with the student. Over the course of a lesson, the student becomes a better student and the teacher becomes a better teacher.

The employment of educational technology – more specifically, networked computers in the classroom – is an attempt to raise the effective “ubiquity” of the teacher. We provide
several examples below. But to set the stage a bit more, we consider how teachers in non-computerized classrooms enhance their presence to the students.

In traditional classrooms, many techniques have been developed to, in effect, emulate the dialectical process between student and teacher described above. The simplest and most common is the in-class exercise, which can range from a simple question put to the class with a request for a show of hands (a “poll”) to a written problem to be handed in and graded. With in-class exercises, the teacher is attempting to give the students a task they can do, or can almost do, and is hoping in turn to gauge what the students are learning. It is, then, an attempt to recover “ubiquity in the classroom.” However, it falls short of reaching this goal in several ways: The exercises will not be appropriate for all students; this is inevitable as long as there is more than one student present. More fundamentally, in this procedure, the loop is rarely closed: The teacher gets only a rough idea of whether students were able to do the exercise, and if not, why not. If the exercise is a simple poll, the responses probably do not carry very much information (even if a majority of students “vote”); if it is substantive, it is impractical to tally the answers in class. The exercise is worthwhile in giving the students practice, keeping them engaged, and possibly helping boost their confidence. However, the teacher is left largely in the dark.

In our research, we have explored how Tablet PCs connected by a network can increase the teacher’s sense of the class, and the class’s sense of the teacher’s presence. The following cases give some idea of how computers can do this. The first two represent older or less powerful technology than Tablet PCs, but still offer interesting lessons concerning this notion of ubiquity. The third is representative of our own recent work with Tablet PCs. Our research also has implications for more conventional notions of spatial and temporal ubiquity.

Case 1: Plato

The notion that computers might be helpful in education goes back many years (Alessi & Trollip, 1985). Its first major incarnation was the Plato system developed on this campus (Woolley 1994). Its intended use was as an “intelligent tutor,” giving routine drill-type instruction. It was eventually used in many courses on the U of I campus. Plato was purchased by Control Data Corporation in 1974, but continued to be used at the U of I and many other locations; running on a large mainframe computer, it was gradually displaced by the newer technologies of PCs and the internet.

When using the Plato system, the student had no live teacher to consult. But the system itself was very much an attempt to personalize instruction – that is, to give the student the feeling of having an ever-present teacher. Lessons were designed so that the student

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7 It also developed into a substantial “social” network, a precursor to the modern internet. The system was not “networked” in the technical sense, but there were many terminals around campus connected to a mainframe computer, thereby giving the same effect. The community of users was large enough to develop “newsgroups” on various topics, an instant messaging system, and early versions of multiplayer online games.
could not stray far from the correct path, as every question was instantaneously graded. For each question, lesson writers attempted to anticipate misconceptions and build in answers that would reveal them, so as to guide students down the most helpful instructional paths. The dream of the Plato developers was to provide the kind of “ubiquitous” teaching that normally comes only with a personal tutor, but at a much lower cost.

Plato-type programmed instruction now has many incarnations in a variety of fields. It is, however, little used on this campus. It is hardly surprising that it is very difficult to replace a live teacher – even one who is responsible for an entire class of students – with a machine. But some interesting lessons were learned:

- Developing lessons for a computerized tutoring system is very difficult and time-consuming. For this reason, these systems are only usable in high-volume learning situations, and, more importantly, in situations in which the subject matter is very stable. At least at the college level, courses are remarkably unstable: the facts of the subject may not change, but teaching approaches do, and lessons designed to fit into a specific course structure may become useless when that structure changes. In short, it is not clear that, when the cost of lesson development and maintenance is taken into account, there is actually any cost savings to be had.
- The keyboard was a limitation on the students’ interaction with Plato. The developers ended up inventing a new technology to overcome this: the computer touch screen. Input modalities are extremely important. The Tablet PC is the logical conclusion of the development of computers with natural input modalities.

Research on “intelligent tutoring systems” continues (Graesser, Chipman, Haynes & Olney, 2005). Interestingly, some of this work is attempting to make the computer better emulate a human teacher, by using various observations (including biometric measurements) to deduce the pupil’s state of mind (D’Mello, Craig, Gholson, Franklin, Picard & Graesser, 2005; Kapoor & Picard, 2005). Tablet PCs are a far richer input device than keyboards or touch screen; it is reasonable to surmise that the characteristics of a student’s writing might better reveal such information.

**Case 2: “Clickers”**

Classroom “clickers” have recently become quite popular (Caldwell 2007), in part due to their being promoted by textbook publishers. These are devices that resemble TV remote controls and can be used in class to allow students to respond to teachers’ poll questions (in-class exercises with multiple-choice answers). Recall our earlier discussion about the disadvantages of in-class exercises in which students answer by raising their hands. Because the answers provided by clickers are recorded, students tend to participate (the choice of whether to count these responses in the students’ final grades is, of course, the teacher’s); and because the teacher gets quantifiable results, coming from nearly all the students, she can form a clearer picture of the students’ knowledge.
Though it is impossible to provide personalized instruction in the classroom, this technology does provide a better illusion of the “ubiquitous teacher” to more students than can be obtained without it.

**Case 3: An introductory programming class**

Introductory programming classes in college suffer from a peculiar problem: Students come into them with very different pre-existing skill levels. It is not simply that they have different abilities; many of them already know how to program. Especially in the first half of the course, it has proven extremely difficult to find a balance between the needs of the less experienced and more experienced students. A large proportion of the class inevitably feels that they, in effect, have no teacher, in that the things the teacher is saying and doing are far removed from the student’s needs.

This past semester (Spring 2007), we tried an experiment. We ran a section of the class in our laboratory classroom, equipped with about 35 Tablet PCs, wirelessly networked. We employed a class structure that could not be implemented without computers. It is a partially self-paced class, with occasional “synchronization” points. The teacher plans the class as a sequence of objectives, each with the same structure: pre-flight (a brief introduction), content presentation, self-assessment, and post-flight (brief recap). The class goes through the objectives together, but they may move at different rates within an objective; in practice, most students remain in synchrony with the teacher, while some go more quickly and others lag. This structure helps keep the more advanced students from getting bored too quickly, and at the same time allows them to contribute to the learning of the other students. (Since the computer prevents them from moving on to the next objective, they spend the time helping their classmates through the current one.)

This class also incorporates a window on the teacher’s computer – which we call the “teacher’s dashboard” – indicating how many students are at each point in the current objective. This is an example of “passive monitoring,” which we discuss further below. The class alternates between lecture time and periods when the students are working on exercises, during which the teacher can consult the dashboard.

This experiment points the way toward new kinds of class structures. In these structures, students and teachers are engaged in a variety of concurrent activities, with part or all of the class synchronizing at specified points. These classes fall somewhere between pure self-paced, “programmed” instruction and traditional teacher-led instruction. In terms of “ubiquity,” the teacher has an excellent picture of the class, as the dashboard tells her where each student is.

**Research agenda**

Two technologies that are now widely available can change the way learning is done: pen-enabled computers (of which the Tablet PC is the most popular, but not the only, example) and computer networks (especially wireless networks). They can help make learning ubiquitous in the usual sense of making it possible for students to engage in
learning experiences at any time and in any place. They can also move us closer to the ideal of the “ubiquitous teacher.”

We believe that, in the future, classroom equipped with pen-enabled computers will be so common that an observer entering a classroom not so equipped will be moved to ask, “How does the teacher know what the students are doing?” In terms of the teacher’s ability to assess the state of the class, pen and paper offer little. Computers – specifically, computers that students use in place of paper – offer a great deal.

The relative scarcity of fully computer-equipped classrooms, the difficulty of writing software for these devices, and technical issues associated with wireless networking have made it difficult to explore the many possibilities offered by these technologies. All of these are temporary problems that we expect will be overcome within the next decade. We list some of the possible uses of the technologies, as reported by various researchers (Anderson, Anderson, Simon, Wolfman, VanDeGrift & Yashuhara, 2004; Anderson, Anderson, Davis, Linnell, Prince & Razmov, 2007; Mock, 2004; Peiper, Warden, Chan, Capitanu & Kamin, 2005; Willis & Miertschin, 2004):

• The basic capabilities of pen-enabled computers are the provisions for writing, erasing, changing pen colors, selecting and copying ink, and saving ink. All represent advantages over traditional chalkboard or pen and paper.
• In a lecture class, the professor may choose to send her ink annotations to students’ tablet, ensuring that they have an accurate copy of the notes. The professor may, on the other hand, decline to do so, because of reported pedagogical benefits of note-taking. Some combination of the two – such as broadcasting skeletal slides – is also possible. A third possibility is for students to share and correct each other’s notes, which now becomes technically simple.
• The professor can send a poll to the students, requesting their answers on a question. This is, in effect, a formalized version of hand-raising, but is better in a number of ways, including the ability to count (easily) who voted and how.
• Ink on a tablet can be replayed, providing a simple recording of the class.
• Students can submit questions anonymously. To keep the instructor from being overwhelmed by questions, various mechanisms could be employed: have a teaching assistant, if available, respond to questions; have classmates respond; have classmates vote on the questions, and then, if a question is popular enough, have it shown to the professor.
• When exams are taken on the computer, it can assist in grading, including providing grade averages on individual questions, information that is extremely useful but rarely calculated.
• The classroom structure can be changed to accommodate a certain amount of freedom for the students to pace themselves.

A possibility we are especially excited by is “passive monitoring.” The record created by students writing on their computers can be transmitted in real time to the teacher, and displayed in various ways. One use is for the teacher to quickly review the students’ notes, although there is rarely time for this in class. (The technology makes it simple for
the teacher to obtain the notes of all students for review after class.) Another use is to provide a summary picture of the class’s writing behavior (who is writing, and how much), but this may not be very useful in itself. Perhaps the computer can find unusual or anomalous behaviors and highlight those for the teacher. In the long run, we are interested to see if the computer can analyze the data in a deeper way, using the ink to determine, for example, which students are engaged with the material and which are bored or tired.

The pedagogical facilities we have just mentioned are intended primarily for synchronous, in-class use, but they need not be confined to that. Students can easily participate in class remotely, doing the in-class exercises and asking questions either via an audio link or by writing on the computer. This provides for spatial ubiquity. The asynchronous case – providing temporal ubiquity – is more challenging. It is difficult to see how a teacher can be ubiquitous if she is not even present. Yet a certain kind of ubiquity might be obtained via post hoc analysis of the student’s writing. The student will not feel the teacher’s presence in the class – that is, as the student is actually taking the lesson – but may feel afterwards as if the teacher must have been there to have the insights the computer has helped provide.

With all these possibilities to explore, we are currently engaged in software development and data analysis. Finding ways to develop software quickly for educational uses would be a boon to teachers and researchers alike. Given the ability to develop this software, these are the research questions that seem to us most interesting:

- How, and how much, can the technology increase the teacher’s “presence” in the class – her sense of the class, and the class’s sense of her?
- What kind of information about the students’ state of mind can be extracted from logs of student’s ink?
- What class structures and teaching methods work best when using this technology?
- How can the technology help education researchers? For example, the passive monitoring data that can be provided to the teacher might prove very useful to researchers.
- What differences arise between in-class learning, synchronous online learning, and asynchronous learning?
- What device/form factor/user interface is best for exploiting the technology?
- How do teachers and students use the computer, and how does it affect the student-teacher relationship?
- How are educational outcomes affected by this technology?

**Readings and References**

There is now an annual meeting, Workshop on the Impact of Pen-enabled Technology on Education (WIPTE, www.purdue.edu/wipte), devoted to the use of Tablet PCs in education; proceedings of the inaugural workshop in 2006 are available in book form (Prey, Berque, & Reed, 2006). Papers on this topic also appear in the annual SIGCSE (Special Interest Group on Computer Science Education) and ITiCSE (Innovation and
Technology in Computer Science Education) conferences; both can be obtained from www.acm.org. The reader may also want to read http://tabletpecucation.blogspot.com/, a weblog devoted to Tablet PCs in education. The annual Eurographics Workshop on Sketch-Based Interfaces and Modeling (http://www.eg.org/egwsbm) is devoted to technical issues in the use of pen-enabled computers, but often with a strong education component.


Chapter 19: Biology: Using a Ubiquitous Knowledge Environment to Bridge the Gaps between Teaching, Learning, and Research in Molecular and Cellular Biology

Eric Jakobsson

Web-based access to information and computational tools has become central to biological research. As the tools of computational biology have become accessible to experimentalists as well as computational specialists, they have also become available for education. Within education, these tools not only provide elucidation of biological principles but also enable students to do new exploration, since the sum total of accumulated data on biological systems is in many respects unexplored territory. In spite of the potential of these approaches, most education in biology is still in traditional form, due to some combination of institutional inertia and a lack of computational orientation of previous generations of students, who are today's faculty. However the new (opened 2005) campus of the University of California at Merced, with the chance to start a new university biology curriculum from scratch, is putting computation at the center of undergraduate biology education. Other campuses, not having the luxury/challenge of starting a brand new curriculum, are facing the other challenge; i.e., changing course to account for the new role of computation and Web based access to information and computational tools in biological research, teaching, and learning.

Where we are today

Today enormous and rapidly growing amounts of molecular biology are freely available to anybody with a networked computing device, together with tools for analyzing those data. The ubiquity of access has grown with the amount of information. Initially access depended on paying for it. Then it increasingly was freely available to an individual if that individual belonged to an institution that would pay for it. Now an increasing amount of archival information is available literally for free, to anybody in the world. This includes the major textbooks in molecular and cellular biology, the major databases of molecular and cellular biology, a large and increasing fraction of the primary scientific literature, and a large amount of content in courses offered in universities. In addition, many biological data analysis and simulation programs are available for free and in many cases open source on the internet. Unlike the famously wrong prediction about nuclear-generated electrical energy, the flow of molecular and cellular biology information of many kinds has indeed become “too cheap to meter”. At the same time, technological advances have made computers more portable. Many knowledge workers (including this author) no longer have a desktop computer. My office is wherever I can connect my laptop to the Internet. I do not need the same physical space for my office that I used to. But I do need connectivity to the internet, even though my hard drive contains far more information than my filing cabinets ever did, bulging with paper as they were. I now find
it so frustrating to do any work without continual reference to information sources that I no longer try to work on my laptop if I am in a place without connectivity.

This chapter will consider the implications of this situation for the future development and utilization of a ubiquitous integrated learning and research environment for biology. In a sense this chapter is a contradiction in terms. It is a chapter in a book---old technology---but is about a technology and a knowledge environment that is dramatically reducing the importance of printed matter. The printing press was originally about democratizing knowledge, making knowledge accessible beyond the elite few. All of the issues around the democratization of knowledge that the Internet has led to, that we struggle with today, were issues initially raised by the printing press. How could one count on the validity of what was in print? In Europe before the printing press, only those who were vetted by the establishment (the Church) had access to the Scriptures. What would happen to standards and rigor if everybody could read the Scriptures and publish and disseminate their own interpretation, their own translation, etc.? Similarly today those of us vetted by the establishment (universities, research institutions, etc.) worry about the quality and validity of the flood of material available on the Internet, material that may be beyond any institution’s capability to control.

And yet the values that books and scholarly and scientific journals represent are as important as ever. A core body of knowledge that embodies intellectual rigor, integrity, and accountability is an essential foundation of civilization. A central question today for all of us who have been entrusted with the curation, protection, and dissemination of such a body of knowledge is: How can this body of knowledge be nurtured and continue to grow and be disseminated and passed on in the new knowledge environment? For biologists we might pose the question as follows: How can this body of knowledge evolve so that it is optimally adapted to meet the needs of society? And maybe a metaquestion; i.e., do we need to worry about how this body of knowledge evolves or will it happen in a sense automatically, like biological evolution? (The metaquestion has no answer. It is a societal version of the question of whether we have free will. Are we the drivers of how our bodies of knowledge evolve, or are we caught up in a tide that is beyond our ability to direct? The analogy I favor is that we are surfers on a wave of historical change in the knowledge enterprises. None of us can change the course of the wave very much, but we can try to ride the surfboards of our expertise and imagination to some place we would like to go.)

How can one properly write a book chapter about a topic that, by its definition, can not be properly contained in a book? I am not sure what the best way is, but here is what I will do in this chapter: I will eschew all normal references. I will also not use url’s, because of their transitory nature. At this time, I believe the best combination of persistent archival knowledge and up-to-date’ness is provided by the search engine. Therefore in lieu of references I will italicize words or phrases that might be useful or interesting to Google as one reads this chapter.

The Pace of Change
The rate of growth in biology information and the rate of change in how we access that information is staggering by any historical measure. The amount of information in the archival gene and protein sequence databases maintained by the National Center for Biotechnology Information has over the last two decades maintained a growth rate of doubling every 17 months. By “partial coincidence” the doubling time is almost exactly the same as the 18 months doubling time for compute power in the world that is embodied in the famous Moore’s Law. I use the phrase “partial coincidence” because high speed sequencing depends on the ability to break an organism’s DNA into short fragments, so that many sequencing machines can run in parallel on the same genome. The subsequent assembly of those fragment sequences into complete genes, gene products, and genomes is done computationally, and is very compute intensive. The databases could simply not have grown at the rate that they have if the available computing power had not kept pace.

Fueled to a great extent by compute power, including special purpose microprocessors for automated experimental instrumentation as well as general purpose computers for analysis and simulation, there has been an enormous increase in organized and curated knowledge—but not by any measure as rapid an increase as in the growth of databases. The pathway from biological data to knowledge and understanding—the domain of bioinformatics—is at once a major bottleneck in understanding living systems and a major opportunity to move our understanding to a level literally undreamed of fourteen years ago, when the hypertext Mosaic Web browser was invented at the National Center for Supercomputing Applications on our campus. The impact of the Web browser on the world can hardly be overstated, and the impact on biology has been as profound as on any other enterprise.

**Ubiquitous Biology Research Using the Biology Workbench**

The Biology Workbench was also invented at NCSA, by a team led by Shankar Subramaniam, now at the University of California at San Diego. The invention of the Workbench followed the invention of the Web browser by just three years. It was not only a pioneering enterprise in bioinformatics, but was also a pioneering effort in Web-based computing, providing an integrated environment for simultaneous search of multiple biological databases, and analysis of data from those databases by a variety of analysis programs. As described in United States Patent 5859972, the Biology Workbench marks the invention of Web-based computing. (The rights to the invention sadly fell into dispute with Subramaniam’s move to California, the patent was not defended against encroachment, and the hopes of the inventors for a future of having their research labs perpetually endowed by invention royalties were not realized.) The interface to the Workbench, and all the databases and analysis programs contained in it, is the user’s Web browser. Therefore the Workbench made bioinformatics research, and biology research using bioinformatics tools, truly ubiquitous. The overall structure of the Biology Workbench that leads to this feature is given in the diagram below.
One day at a scientific meeting in Boston one of my colleagues asked me if there were calcium channels in prokaryotic organisms (bacteria and archaea). I said that I did not know, but I would check and let him know the next day. That night in my hotel room I fashioned a probe sequence from the selectivity filter region of a eukaryotic (plants, animals, fungi, etc.) calcium channel and compared that sequence (by chance a human calcium channel) to the sequences of all known proteins in prokaryotic organisms. I discovered just one, in the genome of a bacterium that lives as far as possible from where any human being could live, in the region of a black smoker (a region of superheated water where lava is being released through a fissure in the deep ocean floor). In my hotel room I discovered a deep relationship between humans and a single-celled organism that lives in such an alien environment that it might be on another planet. It turns out, sadly by some measure, that I was not the first person to make this discovery. A colleague at the National Institutes of Health, Bob Guy, had made this discovery a few months earlier and his paper, unknown to me, was in press at the time that I made my version of the discovery.

But in a broader sense, this was nothing to be sad about. Because it meant that the discovery process in biology had broken out of being confined in books and journals and specialized laboratories and had become ubiquitously accessible to anybody with the requisite skills and a networked laptop.
I will describe in more detail another hotel room discovery that is perhaps of more general interest than a particular ion channel protein. One of the great joys of working in science education as well as scientific research is that one is moved to think of broad questions. One evening at dinner, at a science education meeting in North Carolina, after a couple of glasses of wine, the question came up as to whether modern humans might have interbred with Neanderthals during the period that they occupied the same geographic areas in Europe. Essentially this is the basis for the series of prehistoric romance adventures by Jean Auell, the first volume of which is *The Clan of the Cave Bear*. As in Boston, I said I would check and report the next day. My ability to check depended on a bit of DNA that had been retrieved from a Neanderthal fossil and deposited at the Web site of the National Center for Biotechnology Information.

The next day I returned with the diagram below. This type of diagram is called an unrooted tree. At the end of each branch is the name of an organism. In this case the organism is represented by a particular sequence from the organism’s mitochondrial DNA. The length of each branch on the tree is proportional to the degree of difference between the sequences representing each organism. We make the assumption (not perfect, but usually pretty good) that a tree constructed in such a fashion represents the evolutionary relationships among the organisms. (The key to the validity of this assumption is whether the homologs (similar sequences from different organisms) are true orthologs (derived from a common ancestor) as opposed to paralogs (having separate roots that were created by gene duplication)). In the particular tree below, we are supposing that the tree represents evolutionary relationships among modern humans, Neanderthals, other primates such as *troglodytes* (the chimp), and three species of cattle that biologically capable of interbreeding. The clustering on the tree indicates that humans and Neanderthals are closer to each other than the interbreeding cattle are close to each other, suggesting that the modern human-Neanderthal relationship might have been close enough to permit interbreeding.
Figure 2. Unrooted tree, showing how closely related modern humans are to Neanderthal, as compared to how they both are to other modern primates, and to varieties of cattle, which are often capable of interbreeding.

The specific tasks that were done on the Biology Workbench to create the above tree were as follows:

1) Genbank was searched with the keyword “Neanderthal”, using the NDJINN tool provided within the Workbench.
2) A sequence of mitochondrial DNA, discovered by that search, was downloaded to the user workspace within the workbench.
3) That sequence was used as a probe to find corresponding sequences for modern humans, other primates, and other species of vertebrates, using the BLAST tool provided within the Workbench.
4) The modern humans, primates, and cattle sequences were downloaded to the user workspace.
5) The sequences were aligned with each other, using the CLUSTALW tool provided within the workbench.
6) The alignment was downloaded to the user workspace provided within the Workbench.
7) The tree above was drawn from the alignment using the tool DRAWTREE provided with the Workbench.
8) For display purposes, the scientific names and access numbers on the original tree were replaced with generic names for the organisms, using an editing tool provided within the Workbench.
9) The tree was saved in Postscript format, using a translator provided within the Workbench.

What are the lessons to be learned from the above experience? I would point out two:

1) Ubiquitous problem-based learning is technically possible. It is feasible to have knowledge environments that are navigable and computable and universally available via laptop, notebook, or even palm-sized computers. These environments can enable finding and organizing existing knowledge, and even creating new knowledge by new analysis and synthesis.

2) Ubiquitous problem-based learning is inherently not easy. Solving problems is not easy. The Neanderthal problem above involved 9 different steps. If you tried to read through the steps, and are still reading now---congratulations. There is hardly anything more soporific than reading through a list like that. In researching the Neanderthal relationship, I did not write out a task list ahead of time, but rather followed a pathway marked by the relationships of different kinds of data to each other. So the question is: How can this capability be taught? How can ubiquitous informational and computing capability such as is embodied in the Biology Workbench be used for teaching and learning as well as research?

The Biology Student Workbench---From Ubiquitous Research to Ubiquitous Teaching and Learning

The Biology Student Workbench is a work in progress, and probably always will be. It is our attempt to start with the research-oriented Biology Workbench and create an environment for learning and teaching molecular and cellular biology. Our organizing principle may be stated as follows:

“A teaching and learning environment should meet the student where he or she is and provide a scaffold for the student to 1) acquire knowledge and gain skills that the teacher has judged to be important, 2) explore new directions of the student’s choice, and 3) go beyond the acquisition of knowledge and skills to enable the student to create new knowledge; i.e., to join the research enterprise.”

The structure of the Biology Student Workbench is exemplified by the screen shot below:
Figure 3 Screen shot from the Biology Student Workbench. The overall design and implementation were done by Gloria Rendon, Johnny Tenegra, and Chieh-Chun Chen. The Student Interface to the Biology Workbench was created by Bruce Southey. The work was done at the National Center for Supercomputing Applications on the campus of the University of Illinois at Urbana-Champaign.

The view above shows a screen with three frames. The upper left frame is the scaffold—a verbal and visual framework that leads the student through an exploration of a particular topic, in this example sickle cell disease. The scaffold is riddled with hypertext. The hypertext links govern the content of the upper right hand frame, which displays Web pages that provide either background or more advanced information on the words or phrases in hypertext. The student can either move straight through the text of the tutorial, or follow a hyperlink as needed or desired. None of the hyperlinks goes to a dead end, so the lesson is connected to an effectively infinite web of information. The lower frame is a student interface to the Biology Workbench computational environment. The interface enables the student to drive the actual research tool on a server at the San Diego Supercomputer Center, and do analyses relevant to the tutorial, such as the sequence alignment shown below. The text gives directions on how to use the tool to analyze sequence data.
The Future

At this time we are wrestling with questions both small and large. Among the small but important questions are those of the ergonomics and pedagogy of software design. Should we use frames, as we show above? Frames provide a simultaneous look at the three building blocks of our educational structure---the scaffolding, the information sources, and the compute engine. But the area within each frame is small, so navigation requires a lot of scrolling. Is it better to flip back and forth between different windows? Questions such as this will be answered satisfactorily in time.

Larger questions remain. How do we solve important problems, and how do we train young people to solve important problems, in a world that is becoming (we all believe to the point of cliché) increasingly complex?

I think of the following: Jared Diamond, in the opening section of his book *Guns, Germs, and Steel* is talking to a member of a hunting and gathering community. The community has helped Diamond survive in the wilderness while he pursues field biology research. Diamond has learned of the enormous amount of detailed knowledge of the environment is necessary for the members of such groups to survive---detailed knowledge of the properties of hundreds of plants and animals. The man asks Diamond why some of the
people of the earth, such as Diamond and his countrymen, have so much of the world’s goods while others, such as himself, have so little. Seeing how helpless Diamond would be alone in the wilderness, he points out that it can not be that those with all the goods are smarter. Diamond, thinking of the people he knows in Los Angeles where he is on the UCLA faculty, agrees. And so the idea is born for *Guns, Germs, and Steel*, an exploration of how climate, geography, and ecology have influenced the development of human societies.

I think of another cliché that may well be true of us in modern societies, but possibly not of the hunter-gatherers—the cliché that we only use a small part of our brains—that we are potentially much smarter than we are in fact.

A large theme begins to take shape. Our enormous brain evolved in a hunting and gathering context, and we used all of it to thrive in that context. Then in a few places, because of favorable climate and domesticable plants and animals, we developed agriculture, the productivity of which enabled the growth of villages and then cities. On those farms and in those villages and cities we created simpler environments, in which less of our total intelligence was required to survive. Collectively we were as smart as ever—the sum total of human knowledge grew—but individually we became (is it too blunt to say?) stupider.

Enter the Web which, combined with portable computing, give us the possibility of ubiquitous information searching and problem solving environments. Finally, for the first time since we started on the path to civilization, we have the ability to experience an intellectually interactive environment rivaling in complexity the natural environment of the hunter gatherer.

This should cause us to rethink one of the core assumptions underlying our academic and educational institutions—the assumption that academic excellence implies specialization in a discipline. We have taken it for granted, for example, that one can be either a first rank physicist or a first rank biologist, but not both. In fact, we have believed that within each of these areas one must find a subspecialty. But what if this belief is based on a level of inefficiency in gathering and processing information that is no longer valid? Perhaps needing to go to the library to follow up on advanced references in our textbooks, gathering and filing those paper journal articles to provide context for our research, was a fundamentally rate limiting step in our ability to learn and to produce new knowledge. What if ubiquitous computing and information technology removes that barrier and provides us with the capability to be truly multiple experts, so that deep interdisciplinary collaboration can take place within single brains—so that we can finally use our brains more completely in the pursuit of more knowledge about the world. In the terminology of computers, what if our intelligence has been bound not by our processing capability, but by input and output capability? Ubiquitous knowledge environments will enable us (indeed force us) to confront this question.
Chapter 20: Arts: Technology Pedagogy as Cultural Citizenship

Elizabeth M. Delacruz

Philosophers, anthropologists, psychologists, and educators have long speculated about what makes art special. Works of art embody the feelings, values, stories, and achievements of civilizations, and the study of those works provides a lens through which we come to a richer understanding of what it means to be human. Art also positions as a form of personal enrichment, civic engagement, and as a means for social reconstruction. An eclectic field with diverse and competing interdisciplinary connections, art education has become a hybridized form of citizenship education, layered with overlapping interests in aesthetic and media literacy, visual, material, and multi-culture, health, ecology, cognitive, emotional, and aesthetic development, school and community studies, and technology. With these overlapping interests in mind, this paper focuses on the role of technology pedagogy in contemporary visual arts education theory and practice and describes how one art educator, the writer of this manuscript, makes sense of all these things.

The Ascent of Technology in Art Education

Writings and classroom practices from the past twenty years in the profession of art education demonstrate how the electronic frontier and art education fit together so well (Ettinger, 1988; Hubbard & Greh, 1991; Keifer-Boyd, 2005); and how image making, reception, and consumption are both facilitated through and changed by computer technologies (Freedman, 1991; Emme & Kirova, 2005; Lin, 2005). Utilization of computer technologies increases interactivity between art teachers, between teachers and students, and among students (Koos & Smith-Shank, 1996; Keifer-Boyd, 1997; Carpenter & Taylor, 2003). They enrich artistic and aesthetic inquiry (Hubbard, 1993; Kiefer-Boyd, 1997); contribute to the examination of postmodern conceptions of art (Efland, Freedman, & Stuhr, 1996); and suggest ways to engage students in consideration of philosophical and political dimensions of the technology revolution (Freedman, 2003). Creation of and inquiry about visual productions now extend beyond the realm of fine art or traditional craft, as new forms engage appropriated and seriated digital images, web-environments, virtual galleries, zines, blogs, animation and time-based media, computer gaming, hyperlinked image, video, and audio, and text files, and a host of interactive cyberspaces. Technology-enhanced art programs facilitate constructivist, dialogical, and liberatory educational goals (Prater, 2001; Taylor & Carpenter, 2002); invite a social semiotic analytical approach to understanding digitally manipulated sites, spaces, and images (Emme & Kirova, 2005); and extend beyond classrooms and into the lives of children and communities (Keifer-Boyd, 2005; Knight, 2005). Finally, art education is seen as a catalyst for change in the K-12 sector (Galbraith, 1997; Krug, 2002); and art teacher education programs are engaging electronic media in fascinating ways. This
includes creation of virtual museums, educational multi-user role playing sites, asynchronous interactive hyperlinked research and story telling, cyborg performance, and electronic teaching portfolios containing digital video documentaries of best teaching practices (Keifer-Boyd, 1997; Stankiewicz & Garber, 2000; Garoian & Gaudelius, 2001; Taylor & Carpenter, 2003; Delacruz & Bales, 2007).

Concomitant with the ascent of technology, the aims of art teacher education have shifted over the past 20 years, from preoccupation with visual and aesthetic literacy to attempts to understand and foster multi-media, multimodal literacies (Duncum, 2004). I note a related shift accompanying increased interest in art education technology pedagogy—a concern with cultural citizenship in an age of global media. The aims of art education are currently connected to notions of civil society in a globalized world, now made more possible and more urgent due to the proliferation of digital media and electronic communication networks. The following discussion tracks how I have come to better understand this agenda, highlighting insights of my past ten years of teaching future and practicing teachers what I know about art, culture, and technology.

**A Case in Point: Technology Ubiquity in the Professional Life of a Faculty Member at the University of Illinois**

I *fell into* technology in 1996 at UIUC with an opportunity to apply for a University technology grant in which I proposed to make one of my courses more interactive through utilization of new technologies. I was interested in new art forms, contemporary activist art, and multicultural art education. Inspired by an electronic asynchronous discussion software program that I saw demonstrated at a Writing Across the Curriculum faculty workshop hosted by the UIUC Center for Writing Studies, I surmised at the time that I could engage my students in such interests in more exciting ways through interactive media. Numerous UIUC sponsored opportunities followed, and I have come to appreciate what it means to work in such a technology rich place. I sought out university workshops, collaborated with innovative people on campus who knew considerably more than I did about new technologies, and found immense support in my efforts to bring these technologies into my teaching. I was one step ahead of my students and my explanations were just right for their (our) entry-level knowledge. I have come full circle these past ten years, able at refocus my growing (but still entry level) technology knowledge on things that matter greatly in my field—contemporary art making, intercultural education, critical inquiry/social justice, and preparing future teachers of young people.

*Technology implementations and insights.*

Teaching technology courses both on campus to art education students and off campus to practicing teachers has provided opportunities for me to observe firsthand some of the creative ways teachers and students use electronic technologies. Employing software programs with imaging and hyper-linking capacities, pre- and post-service teachers in my classes have created instructional materials, curriculum plans, interactive instructional web sites and digital slide presentations, digital video productions, and electronic portfolios for personal and professional purposes. We have dealt with the interface of
technology with image construction, graphic design, online inquiry and collaboration, interactive information design, instructional delivery, inquiry-based and cooperative learning, assessment, and technology infrastructure in local school contexts, along with ethical, legal, and feasibility problems. Problems considered include disparities between K-12 technology education standards and teachers’ knowledge and ability to address these standards, student abilities and needs, the digital divide, copyright, censorship, fears of litigation, Internet predators, and widely varied school and community technology infrastructures (Delacruz, 2004).

My adaptations with technology in both on and off campus courses have changed dramatically in these ten years. In 1996, we undertook the arduous tasks of teaching ourselves HTML code and using clunky digital cameras and flat bed scanners to create simple web pages; we worked in computer labs with limited capacities and relied on floppy disks and cumbersome server access for file storage. By 2006 we were creating sophisticated on-line multimedia and digital video portfolios with point and click ease and portability. In 1996, a graduate student asked me if she could type an assignment on her electric typewriter because she didn’t have a computer at home. Students now bring in personal wireless networked and loaded laptop computers, accompanied by a plethora of handheld digital devices: keychain-sized flash drives, compact digital cameras, sophisticated calculators that talk to digital projectors, iPods, cell phones, compact digital audio recorders, and blackberries. Students are plugged in, connected to their mobile digital networks, cued to the latest developments, and eager to adapt them to their own purposes.

Teachers increasingly tell me that 11-year old kids know more about technology than they do. This coincides with the fact that many of my own students know more than I do about emerging technologies. Recent studies indicate that young people use electronic technologies creatively and effortlessly, in widely varied ways, for widely varied ends. The eager adoption of web publishing, digital video production and distribution, social networking, multiplayer role-playing games, and creative utilization of electronic media by millions of young people around the world demonstrates the strength of their desire, unprompted by adults, to learn digital production and communication skills (Rheingold, 2007). Conceptualizing these youth as cyber-nomads, Saveri describes them as tech savvy cultural creatives—digital age creatives, designers, innovators, students, activists, citizens, bloggers, and gamers. They have physical, digital, and social mobility, are opportunistic, and they simultaneously work across media (Saveri, 2005; Lenhart, Rainie, & Lewis, 2001), adopting distinct identities for each (Gross, 2004). These are skills that young people learn in teenage (Rheingold, 2007; Lenhart, 2007) skills that they use creatively and freely on their own but less so and less creatively in schools (Levin, Arafeh, Lenhart, & Rainie, 2002). In short, youth today are global and connected.

Technology in the Privileged American Life and an Agenda for K-16 Technology Pedagogy in the 21st Century: Toward Cultural and Global Citizenship

The ubiquity of technology in the lives these privileged, media savvy youth of today has led many art educators like me to think about the purpose and potential of technology
utilization within art teacher preparation programs and related disciplines concerned with education. As my students have become more tech-savvy, I have begun to focus on the need to distinguish technology training (learning procedures) from technology education (fulfilling aims), and to clarify the aims of technology pedagogy with my 21st century art teachers. Appropriately, I have looked on-line for guidance, and writings about the digital knowledge commons and global civil society have been most useful. Media savvy scholars observe that although highly capable, youth may not be self-inclined to participate in work for the common good without specific guidance from teachers. Technology pedagogy must explicitly teach cultural citizenship.

Cultural citizenship and global civil society.
Cultural citizenship relies on development of two moral capacities, the capacity to pursue rationally a conception of the good and the capacity for an effective sense of justice (Bridges; 2002). Cultural citizenship also entails civic engagement, what Harry C. Boyte calls public work, which he defines as sustained, visible, serious effort by a diverse mix of ordinary people that creates things of lasting civic or public significance. It is here, within the realm of technology pedagogy in the K-16 art room, that connections between art, technology, and the common good are productively forged. In such a framework, new media become the vehicle through which ideas are creatively and persuasively added to the sphere of public opinion over matters of importance, and in which the Internet becomes a place for both intercultural connections and collective action. The Internet, now posed as the realm in which civil society may come together to foster collective civic action both at the local level and in the global arena, creates new spheres for information exchange, debate, formation of public opinion, and fortification of plans for civic actions.

Public work is also full of tensions and conflicts, as individuals and groups from diverse backgrounds and different parts of the world bring varying perspectives, agendas, and life experiences to problems of mutual concern (Boyte, 2002). Citizen activists must embrace and bridge divisions of ethnicity, religion, language, and nationality in the formation of global civil society (Fraser, 2003-2004). Civic friendships, the basis of multi-ethnic coalitions dedicated to public work, form between persons from differing communities who are able to both go beyond distinguishing and separating themselves through identification with particular communities while at the same time maintaining their particularistic communitarian identities within those friendships (Bridges, 2002). Civic partnerships build from these kinds of friendships.

Seeing the arts as a form of personal and communitarian storytelling, for advocates of the instrumental view of art, creation and study of works of art in school art programs facilitates development of communal identity and compassion toward others (Lankford, 2002). Understanding the embedded stories of diverse peoples provides a means by which intercultural connections between individuals with differing needs and expectations may be fostered. Coupled with cultivation of a sense of social justice, political know-how, and a disposition toward public engagement, art education in the connected classroom becomes a tool for social change as student public opinion is forged toward the formation of civil society (Delacruz, 2005).

Procedures for developing public opinion in the classroom are well rehearsed in education. These procedures engage a process of jurisprudential inquiry that adheres to
principles of rational debate and consensus building (Oliver, 1978). But development of the kind of public opinion in the connected classroom that leads to public engagement requires more than rationalization; it requires a classroom context that facilitates a culture of caring (Delacruz, 1997; Noddings, 2005). Classroom conversations and creative expressions must be over things that matter to students, things that are deeply felt. And they must be followed by collective plans of action that involve others, similarly informed by the processes of rational deliberation, consensus building, empathy, and compassion. Creating warm and caring classroom conditions facilitates the desire to form alliances across divisions of race, gender, class, ethnicity, and a host of other differences that divide students from one another, and the desire to take collective action on behalf others.

Civic engagement in the 21st century is global. Issues and conditions that impact people worldwide impact us. Technology pedagogy for global citizenship is really about kindness, listening, sharing, and doing good things because we care about one another in a smaller and more fragile world. Returning to the idea that the power of art resides in its specialness, the path ahead in the connected art classroom requires curricular choices and instructional strategies that foster notions of citizenship in a globalized world. These choices and strategies build from a belief that art education is about the things that matter greatly to people and that technology permits inquiry and action on those matters in productive ways.

Readings and References


Chapter 21: Writing (1): Writing with Video

Maria Lovett and Joseph Squier

From the beginning I have thought that I needed an alternative way to express myself, besides writing. With a world so memorized and influenced by their TV sets I think it's important to try and reach people in a way that they choose to receive their information. Video is the quickest way we have to portray a message to someone. We could write a 20 page research paper that will get the message across, or we could present it in a 10 min video… Watching a video is more engaging and feels less like homework. Video presents images that can argue the perspective. People grasp things better when they are seen visually. They can recall them better as well.

– Veneta, senior, psychology major, Writing with Video, Spring 2007

Literacy, Readers, Authors

The printing press democratized print literacy, and in the process gave rise to the modern university; it promoted an expanded universe of knowledge and discourse that could extend beyond medieval monasteries and into the secular world. The availability of printed texts drove the ascension of alphabetic literacy to the point that, until very recently, the common assumption was that to be literate meant the ability to read words on a page. Of course, by the end of the 20th century it was evident that contemporary literacy was becoming increasingly multimodal and hybridized. Today’s communication landscape is characterized by forms which frequently combine the printed word with images and sound. This is particularly omnipresent in the reception and production of video in our contemporary world.

“The new video, with the assistance of computers, should become the means by which our more sophisticated information, ideas and experiences are recorded, shared, explored and analyzed. And as writing and print once did, the new video should begin to transform the nature of our information, ideas and experiences” (Stephens, 1998, p. 201).

However, this evolution of communication has created significant tension within the modern institutions. Students have had to confront an increased disconnect between their lived experience and the norms of the academy. One obvious friction point has been the undergraduate composition requirement that is an almost universal aspect of completing any degree. Historically, composition has meant writing. It was assumed, at least within the academy, that the most legitimate and powerful rhetorical forms were attached to the technologies of ink and paper. The problem, however, is that this premise no longer maps onto the ubiquitous experience of today’s student, who encounters a densely constructed communication landscape in which printed text is but one among many rhetorical forms, and where words often function in concert with other modes of persuasion and discourse.
As we move into an era of ubiquitous networks, it is also important to note an increasing breakdown in the division between author and audience. The printing press increased access to knowledge, but contemporary technologies such as camcorders also afford a powerful means of authorship. When this affordance is teamed with easy access to high-speed global networks, the result is the emergence of social networks on a scale never before seen. Sites such as MySpace and YouTube provide a glimpse of a future in which citizens will be constantly engaged, not just as readers but also authors.

Emerging from this technocentric space, and acknowledging the lived experience of our students, we developed a pedagogical approach that strives to meet the needs of 21st century citizens. The course *Writing with Video* was developed as a response to these tensions. Specifically, we wanted to promote an expanded definition of the term *composition*, one that we saw as being both more inclusive of multiple communication media and also more reflective of the contemporary world. *Writing with Video* is intended to empower students by giving them a diverse package of rhetorical, analytic and creative skills. Methodologically, the course, informed by the pedagogical praxis discussed here, is an applied example of ubiquitous learning successful at the University of Illinois in Champaign-Urbana.

**Classrooms, Laptops and Ubiquitous Access**

Students enrolled in *Writing with Video* are loaned an Apple laptop computer for the duration of the semester. The machines are specially configured with software that allows students to write, produce video, and connect to the internet. Students are expected to bring the laptops to class, but most choose to carry them constantly. For the typical student, the laptop serves multiple functions: writing journal, research tool, video production studio, communication conduit, publishing platform, viewing screen, and media archive. Many students also use the laptop for purposes not directly related to their work in *Writing with Video*; storing music collections, surfing the web, accessing their e-mail, instant messaging, or completing work for other classes. This is encouraged. The repetitive point we wish to make here is that learning should not be fragmented into disparate parts. Instead our educational philosophy promotes a form of living pedagogy: we emphasize a process that connects knowledge acquisition within intuitional spaces, with those lived experiences performed beyond classroom walls.

Likewise, *Writing with Video* instructors are encouraged to meet with their students outside of their assigned classrooms. Meetings, sometimes an entire class or perhaps small working groups, have been convened at the library, in other campus ‘commons’ areas, outdoors, and at local cafes. Our assumptions about classrooms – rectangular rooms with lapboard desks and lecterns – are under rapid revision, much of it driven by

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8 *Writing with Video* began with a pilot course taught by Maria Lovett in the Summer of 2005. Due to its success, in the fall of 2007 six undergrad sections and one graduate section of *Writing with Video* that meet general education requirements in three disciplines at the University of Illinois – advanced composition, arts and humanities, and comparative Western cultural studies, and serve over 120 students.
technological change. We believe that traditional notions of standardized classrooms will progressively give way to learning spaces that are flexible in their configurations and uses. Laptops are one way to promote a new type of classroom dynamic. In particular, we see them as an attempt to erase the division between classroom time, ‘homework’, and real life; divisions that may make less sense to students – enabled as they are by cellphones and instant messaging – than to their professors.

Laptops give students the means to take advantage of the increasingly ubiquitous nature of contemporary media and communications networks. Rather than being forced to go to a traditional computer lab to conduct research or produce content, students can now engage in all aspects of media research, authorship, and analysis on a 24/7 basis. For most Writing with Video students, place has become less of a factor. They can complete coursework as easily in their apartment as they can on campus. Students can produce video when the computer lab is shut down, and can research projects even when the library is closed.

Another important component in the laptop program is the utilization of a proprietary Apple software program called Pages. This software effectively combines a word processing program with a design layout program, complete with several design templates. Most significant for our purposes, Pages can seamlessly and easily incorporate non-text elements such as video, still images, and audio. In other words, Pages allows authors to create sophisticated and visually compelling hybrid documents that communicate across multiple modes: text, images, and sound.

Writing with Video students create Pages documents that capture and inscribe every aspect of their project. Typical Pages files include lists of brainstorming ideas, research topics and sources, storyboards, shot lists, scripts, video rough cuts, audio recordings, meditations on unexpected questions or problems encountered, unused video clips and outtakes, self-reflection and analysis. Frequently, these documents are then shared with other students – electronically via the network, of course – who often provide further written analysis and feedback directly in the original document. Lastly, students then upload their finished video projects to iTunes, where they can be viewed, and even downloaded, by other students.

Course Assignments

Writing with Video re-defines what traditional educational practices considers as evidence of learning – the products. Our method does this in two ways: first, by valuing process as well as product, and secondly by utilizing video and multi-media as a form of composition. This is best explained by highlighting the assignments.

Assignments are designed to begin with self-inquiry and move towards community and social engagement as a form of agency. Keeping detailed journals, students pose questions and conduct research to investigate their topic. In the field, students are situated as visual anthropologists or ethnographers. Assignments incorporate reflective writing
about the production process – shooting, editing and sharing the video. In addition, students engage in peer reviews of work-in-progress and completed projects. When evaluating their final videos, their reflective process as documented in their journals is significant.

Because *Writing with Video* is designed for students with little or no prior experience producing video, early assignments are meant to help students begin building a visual vocabulary and create links between written language and visual language. Each assignment builds upon previous work and becomes progressively more complex and ambitious.

*Project 1: Adjectives and Motifs*

Early projects ask students to draw upon aspects of identity and personal concerns while simultaneously becoming familiar with the cinematic vocabulary and tools required to compose in media. Student must consider form in relation to content as informed by principles of design and studio art practice. Emphasis is placed on encouraging students to “see” the world more self-consciously and reflectively, and to give those with limited experience in the visual realm a comfortable entry point for creating visual work. Students translate a series of adjectives into short 20-second video vignettes, and create one-minute video pieces that convey a simple visual or conceptual motif. Students write self-reflections about their finished work and the class also engages in a group critique-style evaluation of the projects. This provides the opportunity to begin a conversation about standards by which visual communication can be deconstructed, evaluated, and critically analyzed.

*Project 2: Aesthetic Writing*

Next, students are asked to write an expository essay about an event that was significant to them; an evocative piece of aesthetic writing. This essay employs descriptive language to *show* rather than explain their experience. The assignment draws upon performative ethnographic writing techniques (Madison, 2005). Students are asked to make use of this multi-sensory articulation when translating their essay to the screen. This project encourages students to compare and contrast writing and video as two descriptive modes, and also serves to introduce students to the significant relationship between image and sound. At this point, students are focused on representing themselves, their own thoughts and viewpoints, which will then provide a useful counterpoint to the next project.

*Project 3: Representing Others*

For the third project students produce a short documentary – an environmental portrait of a person and a place. Through this assignment students investigate issues of subjectivity and objectivity in art and media representations. First students determine a subject – this process includes writing an intersectional essay to reflect on who “we are behind the camera” and how “who we are affects what we see.” In addition, this assignment asks students to contemplate moral and ethical dilemmas associated with representing another person. Student projects have explored topics such as: a middle school for girls, women in hip-hop, Asian Americans at UIUC, a single mother in college, a homeless man on
Green Street, the housemother of a sorority, a waitress at a local dinner, and the constructed reality of an internet blogger, just to name a few.

Project 4: Visual Argument
For the last assignment students are asked to take a position, to share a point of view on a concept, issue or idea that concerns them. Focus is placed on video as a rhetorical medium – with parallels drawn to rhetorical writing – and how video is used in contemporary culture to inform, persuade, or even indoctrinate. For this final video, students frequently take on timely topics being debated in the culture at large. Some have re-mixed popular culture to speak back to issues of racism and the commodification of culture. We encourage students to utilize the resources around them – many graduate students and faculty members are doing research that lends itself in a compelling way to video representation. For example, a group of students in the pilot course worked collectively to take advantage of innovative research being conducted at UIUC by Rasul Mowatt about postcards documenting lynching in the United States. Combining their own research, and interviews with Mowatt and a curator from the Chicago Historical Society, the students produced a disturbing yet enlightening video entitled “Lynching as Leisure: America’s Forgotten Pastime.”

Other students have used the progression of assignments to explore a single theme – beginning with the personal and then creating a video to speak back to the bigger societal picture. For example, throughout the semester a student by the name of Valerie explored her identity as a Philippine-American, and issues of discrimination and oppression – both in a personal sense and in terms of confronting manifestations of media representations promoting ideological messages. In her “aesthetic writing” assignment, Valerie wrote an essay about an experience of having her haircut – the hairdresser commented that her hair was coarse because she was Asian. Valerie used this racist experience in her life as a point of departure for her video. She produced a video composition using magazine images to critique the proliferation of the ideal definition of beauty as whiteness. In her “representing others” project, Valerie interviewed staff and students from the Asian American Cultural House. Finally, for her last project, Valerie collaged historical research, her own poetry, sound, text and images, and drew from not only personal experience but her education as a creative writing and english major to create a video essay that resonated with post-colonial literature.

Many former Writing with Video students have gone on to implement media arts projects of their own. For example, one former student has developed a project with local girls in Champaign exploring black girlhood and another will soon be implementing a photo and video documentary project with children in South Africa. We make this point to address the need in education to advocate life-long learning – a living pedagogy if you will – and empower our students as not only co-learners but as co-teachers.

Pedagogy as method
The philosophy of *Writing with Video* is informed by critical pedagogy, and the theory and praxis of media production, design, and art making. As pedagogy and as intervention, *Writing with Video* departs from the analytical to include the participatory. By *intervention* we mean that *Writing with Video* intervenes in pervasive forces of representations, by positioning students, as cultural producers to author their own media from a critically informed perspective. *Writing with Video* combines critical literacy with hands-on production practice to trouble issues of representation. The methodology re-defines what is deemed the learning environment, positions students as cultural authors/producers, and utilizes a problem-posing approach as Freire (1970) advocates, to allocate spaces for students to de-code and de-ideologize the symbolic.

*Writing with Video* challenges students to question how we negotiate, resist, and re-author popular texts in all modalities. Through *Writing with Video* students confront the commodification of culture and the widening gap between the producers and consumers of such popular texts. To teach criticality without also providing our students the skills and tools to re-present their stories fails to intervene in oppressive cultural conditions. *Writing with Video* seeks to disrupt the separation between what students experience in and out of traditional learning environments. Such inconsistency has resulted in what Maxine Greene (Goodman, 2003) calls ‘the language gap’ between the print-based preference within institutional spaces and the audiovisual and digital culture that is prevalent in our students’ lives and their meaning making processes. To initiate student-led inquiry on a variety of topics, the course utilizes a sincere appreciation for lived experience and what students already know. The interventionist pedagogy of *Writing with Video* situates students as researchers. Data is collected through written text, images and sound. Students reflect upon, share, and discuss this material. Intersecting pedagogy and research through video production situates students as media arts-based inquirers to investigate the world in which they live. It is through this approach to teaching and learning that *Writing with Video* addresses significant issues relevant to ubiquitous learning.

Three pedagogical themes inform the *Writing with Video* curriculum. Firstly, the need to employ critical literacy with hands-on production practices to identify, isolate and unpack problematic and oppressive issues of representation in mass mediated contemporary culture. Overwhelming stories and images in the media *narrate* the experiences and characterizations of others, but they are rarely afforded the chance to *show* their own story back. As Elizabeth Ellsworth (1997) explains “The process of representation is not a process that reflects reality. Media are not mirrors of the world. They’re not windows onto the world. Media re-present the world. Representation presents its subject again, in ways that mediated it through language, ideology, culture, power, convention, desire.” When we acknowledge and become conscious of this alteration “re-presentation becomes recognizable and available as a crucial site of social, political and educational struggles over what particular people, events and experiences will be made to mean” (p. 76). *Writing with Video* addresses this not only through textual analysis but also through affording students opportunity to author and disseminate media productions to *re-presents* what has been traditionally presented.
Students are situated as researchers, educators, and media authors. This disrupts the teacher/adult as expert model, and dismantles what Freire (1970) calls the banking-model of education and situates students as experts in their own experience. As a philosophical framework for the process of the class this also alleviates the educator from feeling responsible for keeping up with technology at every turn – students share what they know – technically and conceptually. Furthermore, with online distribution sites such as YouTube and others – students can share their knowledge and ideas with an audience beyond the classroom. This notion of sharing what they know and learn in the public sphere impacts how students engage in the learning process, revise material, consider their audiences and offer up a unique video representation of what they have discovered.

Second, Writing with Video critically considers the relationship of form and content. Our pedagogical method specifically addresses not only the subject matter and content but also the form. Students investigate the relevance of composition, structure, and construction as a crucial aspect of the content itself and how this impacts knowledge production. For example, when recording in the field with video -- what is included in the frame is as relevant as what is left out. How the images are composed, what angles are used, the setting, etc are relevant to understanding the content. Such consideration adopts principles of reflexivity in filmmaking as evident in the praxis of filmmaker and scholar Trinh T. Minh-ha. Trinh explores morality and issues of representation to theorize with the camera – using cinema as “a form of reflexive body writing…with the understanding that no reality can be ‘captured’ without trans-forming” (Trinh, 1992, p.115). All of these decisions made by our students are relevant to what the overall message means and how it may be interpreted. They write with text, but they also simultaneously write with the camera.

Third, Writing with Video re-define the learning environment through technology. This occurs on multiple levels, and permeates every aspect of the course. Camcorders, audio decks, editing software, and a whole host of digital tools are harnessed as inscription technologies that foster new ways to explore, capture, synthesize, and represent the world. Laptop computers provide an intersection point for research and production – frequently fusing these activities into an integrated single activity – and also engender different understandings of classroom use. Electronic publishing venues and emergent social networks provide students with new and expanded audiences for their own work, giving them access to the work of other authors and making them a part of a much larger, sometimes global discourse.

Conclusion

Writing with Video yields specific attention to the process of communicating with video as a rhetorical device. The pedagogical process seeks to have students recognize the multiple modes available to them in making meaning. The emphasis on process is fundamental to the pedagogy supporting Writing with Video because it makes the cognitive process of translating experiences, perspectives, and ideas into a product utterly
explicit and conscious for students. When students become producers and authors, rather than simply consumers of new media texts, they gain a fuller understanding of the ways in which new media shape how information is structured, organized, understood, and evaluated. They learn to look at, rather than simply through, such texts (Lovett, et al, in press).

Because composition courses enroll students from across the university, *Writing with Video* has helped bring art and design expertise in visual communication to a wider cross section of students. Students have enrolled from art and design, education, communications, computer science, media studies, cinema studies, english, psychology, business, and engineering. The interdisciplinary reach of the course allows students to re-visit what they are learning in other courses and explore it in the visual form. The diversity of academic backgrounds has made for a lively mixture of unique voices and agendas. Media and cinema studies students in particular have mentioned how grateful they are to put into practice some of the theoretical knowledge they have gained from their other courses. A psychology major recently produced video interpretations of theories she had been reading in another course about the cognitive awareness of mortality. This cross-disciplinary aspect of the course reinforces how important it is for students to continue to make use of what they know, and push themselves to further develop critical thinking skills.

The course encourages students to demonstrate new technologies they are using, such as podcasting or sound editing techniques. These technology-enabled social spaces are aspects of our students’ lived experiences, and this often makes them the resident experts. Consequently, *Writing with Video* instructors frequently find themselves being educated by their students. In a course like *Writing with Video*, where multiple inscription technologies are merged into something altogether new, we have found that students and teachers can learn equally from one another. Too often learning environments are structured in the top-down, hierarchical model. By re-defining and offering new theories and methods for communication, *Writing with Video* challenges this historical structure. If we “reveal the frame” of the pedagogy and research – the process and knowledge exchange can be empowering for all participants.

**Student voices**

Often as researchers and scholars we summarize the work and actions of our subjects. Our goal is to privilege the insight and knowledge of our students. So we conclude this chapter with selected testimonials from recent students.

**Nate, sophomore, undecided**

*When you have the camera in your hands you think to yourself what can I shoot that will make my movie better? ... The composition of every shot you have creates text within the film. It could be because of the angle that you use or you decide to place the interviewer on the right side of the screen with the background dominating the frame. Everything you*
do creates a different feeling for the viewers. You also learn that through editing you can make someone look like a complete jerk or like the nicest person. You have to create the characters for the movies just as the author of a novel has to create the characters. I realized that making a video is no different than writing a paper. In every one of my films I always wanted to have a beginning, middle and end and most importantly I wanted it to flow.

**Elise, senior, photography**

I do not like writing, but this class presented such a different type of writing. [The journal] was so personal and helped me figure out my intentions for making my work and thinking through what I learned, liked and disliked, had problems with… The amount of writing is necessary, being a Advanced Composition course. But really, I never felt like I was writing a ton. 15 pages seemed to go by quickly when doing the journal because it is PERSONAL. It is of OUR experiences as students. Nothing is more depressing than to write about something you have no interest in…

**Victor, senior, computer science**

I think an empowering aspect of the class is its use of technology, and a powerful aspect is its confrontation with ethical values… I like how through this class we became literate in how to “read” films through the process of making them. The idea of visual evidence was very helpful for me. It made me keep in mind my audience and to focus more on what was in the frame of the final cut. Since video can be so powerful, I’m glad we learned about representation and subjectivity. Being conscious of and acknowledging my own biases has helped me be more objective (ironically)… We were constantly encouraged to address these issues when making our own films.

**Veneta, senior, psychology**

It's so important to consider every single part of it: the structure, form, composition, shots, angles, colors, sound, speed, music, etc…. Being conscious of how all of these structural things affect the message is so important… I am now more aware of the types or reactions other media sources are trying to get out of me. I really believe that it is so important to be aware of how style affects us. …To understand that there is such a thing as different perspectives is so important. It helps us understand and communicate with each other. We could be looking at the exact same situation and interpret it differently.

**Emily, freshman, undecided**

I’ve always loved the worlds of books. Instead of relaxing in the comfort of the freedom of words, I wanted to work with something a little less in my head and more in reality. I wanted to use this class to explore the tangible world visually with new eyes. I found ways to make the tangible and the intangible collide, which is such an amazing thing to be able to do. I was able to tangibly express my intangible feelings and the process I went through as I explored death and life in my aesthetic video. With the proliferation of visual
technology in our culture it was so useful to learn the basics of creating a video. I felt like
I was learning how to write all over again.

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Chapter 22: Writing (2): Ubiquitous Writing and Learning: Digital Media as Tools for Reflection and Research on Literate Activity

Gail E. Hawisher, Paul Prior, Patrick Berry, Amber Buck, Steven E. Gump, Cory Holding, Hannah Lee, Christa Olson, and Janine Solberg

Ubiquity in learning and writing

Whether in sociocultural notions of mediated activity and agency (e.g., Wertsch, 1991; Scollon, 2001), the flat dynamic assemblages of actor-network theory (Latour, 2005), Hutchins’ (1995) notion of functional systems, or Lave and Wenger’s (1991) account of situated learning, recent theory and research have foregrounded the ubiquitous character of social practice, that is, the ways situated activity inevitably spreads out across time and space. Independently and with colleagues, we have been involved in studying what Prior (1998) termed "literate activity," that is, activity "not located in acts of reading and writing, but as cultural forms of life saturated with textuality" (p. 138). Examining this ubiquitous character of literate activity in the writing processes of undergraduates, graduate students, and professors (in part through asking them to draw visual representations of their processes), Prior and Shipka (2003) described the intricate ways writers’ work is distributed across diverse contexts as well as how writers select and structure contexts (people, places, and tools) to support their thinking, textual production, and affective-motivational engagement. Selfe and Hawisher (2004) and Hawisher and Selfe (2006) have explored how people forge literate lives in this digital, information age and live their days in a variety of technological and cultural settings.

From our perspective, the ubiquity of literate activity is not new. Digital and new media technologies have not created ubiquity, just as they have not created multimodality. Multimodality and ubiquity have always been there: what is remarkable is how ideological framings and practices of selective attention have allowed them to be so widely ignored and denied. That said, digital media have altered—and continue to alter—the practices and potentials of ubiquitous writing and learning as they have similarly contributed to notions of multimodality.

In this chapter, we take up this notion of ubiquity and consider how video, sound, still and moving images might inform our understandings of literate activity when these tools are put in the hands of writers themselves. Specifically, we focus on video clips that academic writers have created of their own writing processes—videos that include such everyday objects as alarm clocks, coffee makers, city lights, subways, cornfields, and even an iguana named Caliban. We show how digital media can offer new images of the dispersed character of writing and learning, not as punctual events but as emergent flows. Overall the chapter argues for the use of video and other digital media as tools for
reflection, research, and representation of ubiquitous writing and learning in this early 21st century.

For the past 12 years, in graduate seminars and writing across the curriculum workshops, Gail Hawisher and Paul Prior have been asking academic writers to draw images of their writing processes, drawings where writers feature texts, writing tools, clocks, food, people, pets, and various concrete scenes, activities, and tropes. Two years ago, in connection with the Writing with Video initiative on campus (see Lovett and Squier’s chapter), Gail began asking students in her seminar to produce digital videos that would represent their writing. The assignment read: You should attempt to capture a representation of your writing processes on camera. You do not have to video yourself, but you do need to try to represent some of the thinking and processes you experience as you approach and carry out a writing task. What follows are five first-person accounts that suggest some of the ways that task was taken up and understood.

Private Space and Public Performance (Amber Buck)

Asked to represent my writing process through video, I first interpreted this idea literally. I thought about filming my typical paper-writing activities, sitting in front of the computer for hours. I grappled for weeks about the meaning of that self-representation. Should I show myself as I actually look when I write a paper? (My vanity told me that no, I probably shouldn’t.) What meaning would my audience get out of this experience? How would I appear as a writer if I showed myself in front of the computer? I do a lot of research; how could I show that process in a way that looks authentic?

I was preoccupied with thoughts of who was going to watch my video. I always write alone, and the idea of having an audience that I would allow into my private space was unnerving. It was like inviting the entire class over to watch me write. There are elements of this process, like messy hair and pajamas on Saturday afternoons, that are best left unrecorded.

I decided in the end that it would be best to use a metaphor as a way of talking about my writing process. Instead of focusing on myself in the video, I decided to film my iguana. The more I tried to use Caliban’s wanderings around the house in my video, the more it seemed like the perfect choice. Showing Caliban deciding whether or not to jump off the
bed, for example, became a perfect representation of the way I often put off my first plunge into the text. Filming Caliban was my way of not showing my writing.

Looking back on the film later, though, I realized that I still portrayed my process pretty directly. As I write, everything within the space of my home becomes wrapped up in my acts of writing and thinking through the connections I need to make in a text. Not only do I sit in front of the computer to work, but in watching Caliban explore the corners and dark spaces of my house, I am working through my ideas as well. Since this video was made, Caliban has taken to sitting in my bookshelf as I write, which completes the circle of my writing process. She leads me from these other activities to record my wandering thoughts into text.

*Each of the five vignettes includes still images from the video. The stills miss much of what the videos convey. Some videos have voiceover narratives whereas others use animated on-screen text. All use music, sound effects, and particular pacing to convey affect, atmosphere, and modes of engagement.*

**Like an Inconsistent Heartbeat (Christa Olson)**

I can’t remember if a tripping heartbeat was part of my initial plan for my writing process video or if I added it after the fact, but when I think of that video now it’s the stumbling pulse of the soundtrack that I think of first. That ubiquitous, yet inconsistent pulsing increasingly seems an appropriate accompaniment to the fits and starts of my writing process: a constant heartbeat that refuses to keep its meter. In my video’s alternation of image and black screen, writing and recreating, I tried to foreground the recursive, everyday nature of my writing process – happening in concentric circles of years, semesters, days. That rhythm of key-click, time-pass, heartbeat, and swallow all led, not surprisingly, to a soundtrack based on the idiosyncratic pulse of writing. As the process stumbles toward its peak, the heartbeat takes over and becomes steadier, propelling me forward with the tripping click of keys and the sharpness of disciplined breath, yet there is no conclusion. There is no final thud that ends the process. There is only the gradual fading out of the pulse with the clear implication of its continuation.

Because it is organized around contrapuntal rhythms of working and wandering, my video emphasizes the ways my writing expands beyond the actual action of putting down words. I do my best thinking, my best writing, when my hands are occupied with something other than the incessant rhythm of typing and my eyes focus on something
other than a pulsing cursor. Walking, cooking, staring into the distance: these are the activities that reveal connections, spark synthesis, and send me rushing back to typing. In the video, whenever the camera faces my computer, the running narrative trails away from the task at hand as my attention invariably slides to other things. When the camera and I wander away from the keyboard, the narrative turns to topic exploration and theoretical connection. I had never really realized the extent of that contradictory, yet generative rhythm until I saw it played out scene after scene in my video.

Composing my video made me generally more aware of my writing as integrated into the rhythms of days. That awareness has, in turn, improved my ability to accommodate and alter the rhythms of writing. Mapping my writing process through video hasn’t revolutionized my activity; it has, however, helped me see my writing as an everyday, ubiquitous practice.

Each of the five vignettes portrays the writing process as ubiquitous, as spread through life, not contained in acts of inscription alone. They convey this ubiquity through concrete representations of acts of writing, but especially through film tropes (e.g., of journeys, of cooking, of ups and downs).

**Anatomy of a Writing Process (Video): Writing as Meditation (Steven Gump)**

When challenged to portray a complex, creative, multilayered, multidimensional activity (writing) through an equally complex, creative, multilayered, multidimensional technology (video), I was initially caught up in a complicated, recursive web of meaning: How could I distill (simplify), translate (represent), and create (implement) a video of my writing process? Did I even have a writing process, in the singular? Ultimately, I embraced the ideas of inspiration and imagination. These two related engines of creativity would, I hoped, enable me to capture the essence of at least one particular writing event. The challenge was especially large for me, though, since I was new to both the technology (never before having held a digital video camera) and the software (never before having edited video).

I crafted my video around the inherent complexities of mediated translation. Using unfamiliar technologies, I had to translate my idea of writing to (my idea of) video. Unchartered territory this was! In a deliberate attempt to place my classmates on unfamiliar terrain, I introduced a Japanese motif symbolic (in the West) of mystery and imagination.
A three-minute segment of shakuhachi (a type of bamboo flute) music, performed by my Japanese flatmate, provided the soundtrack and thus set the mood; Morizou, a mascot of the 2005 World Expo in Aichi, Japan, was my co-star in the writing process. Yes, I am guilty of self-orientalizing—of “othering” myself as different and, on a certain level, enigmatic. But are not all writing processes, beyond the shared technicalities of the writing act, to some extent unique and context dependent? As a tool for Zen meditation, the shakuhachi effectively emphasized the way I frequently write: alone but for the presence of my writing tools, my material accomplices in the writing act. To me, then, the idea of writing as meditation was not too far off the mark. Morizou became my muse as I attempted to mystify the idea of inspiration, a concept that is rarely straightforward (or, if straightforward, rarely believable) in narrative descriptions of the writing process. The result may have duplicitously suggested that I write with ease or confidence or an absence of stress—the ideal rather than the ordeal of writing. But so much of life in this age of ubiquitous learning is already frenetic, unfocused, overloaded, and fast paced: I felt I could undermine those tendencies, even if momentarily, by portraying one writing process through a relaxing, meditative video.

Themes link these videos. Steve features Morizou, a stuffed being, represented as his muse. Amber uses Caliban, her iguana, as a stand-in for herself, but also as a living being who is somehow integral to the process. Christa’s dog, Ceisaf, makes several appearances, taking walks that become part of the shifting rhythms of her work. Hannah and Cory independently focus on night travels in cars and public transport through rainy city streets.

A Writer’s Journey: Reflections (Hannah Lee)

The first thing that came to mind when I was assigned the writing process video was an image of Charlie Chaplin from Modern Times, as he gets caught in the cogs of a giant machine—a metaphor for the beginning of my writing process. As I held this image in my mind, other metaphors came into view: wheels turning, representing my mind at work; close-ups of eyes, representing the various sources that I turn to before writing; public transportation, representing the writer’s journey. Images that are ever present in my daily life: images that, when placed together, take on a deeper meaning.

My video camera went with me wherever I went—the bus, the airport, my apartment, my mother’s house. I knew that I wanted to collect a montage of my daily
activities, to translate these images, sounds, and words into something that would portray the mundane, yet mind-wrenching activity that is my writing process.

Notions of stretched and retracted time were invoked. Time seemed to pass by without my noticing as I worked on the video—which is nothing like the dread and procrastination that usually accompanies my typical writing assignments with their ever-present deadlines looming before me. The hours it took to get the various shots of me typing at my computer amount to a few moments in the video. Yet the repetitive, insistent cuts evoke the feeling of stretched time. Quickly paced cuts of the activities that I engage in while not writing—checking my email, going for a walk, getting a drink of water—push their way into my writing process and keep me from it, all the while engaging with it, briskly furthering the process along.

As I look back at the final video, the metaphors that I began with begin to resurface. That first image that I had of Charlie Chaplin has translated itself into out-of-focus city lights—both emblematic of the beginning of my writing process, in which things seem stalled and unclear. The initial image of turning wheels and public transportation has found its way in a more palpable form, through my (and ultimately the viewer’s) point of view in a moving car and bus. The metaphor of eyes signifies the various perspectives and ideas that I’ve gleaned. And the metaphor of the writer’s journey has weaved its way throughout—in a recursive loop that begins with uncertainty, and ends in a moment of breakthrough.

Writing as a journey is a familiar metaphor. However, writing as a car ride through a rainy night, in an urban setting, with sad meditative music in the background, is not just an abstract journey. It is a specific trip through a landscape and with a particular texture of rhythms—rain on the windows, wipers screeching, the beat of the music. Digital video representation easily foregrounds what print seems to easily elide, that writing is embodied-activity-in-the-world, that it is consciousness in action, that it is saturated with affect and identity, that it is social as writers interact with others (people, sometimes animals, and even things).

Writing for the Eye (Cory Holding)

Video moves metaphor fast as you can blink: two men descend to the subway. This night is New York. A spring breeze comes. But if you listen, I am talking about coffee. You (the viewer) are asked to attend with me this siren song of procrastination: “For those
handful of seconds when you’re in line, and then the sort of microseconds when you’re sipping, you have a mini-distraction. You’re not thinking in that half a second that you even can be typing.” Follow the gentlemen around the corner and cut to black.

Sluggish to start, the train blurs to a steady clip, windows revealing in staccato motion the stare and gesture of people you will not see again. But this, with the gnashing hum of acceleration is meant to suggest the subterranean feel of thinking—the fleetingness and precipitation of ideas you must catch to pen. The train shoves into the tunnel. It quiets into voiceover: “Your heart beats a certain way. Sometimes you have an endorphin rush. But I think writing isn’t fun. Um, which is why I’m so massively in need of distraction.”

City lights from a car window fade from focus to dull edged coins of orange, blue, white, and flicker with every quick passing obstruction: “You just want time to kind of yawn. Between sit-downs to write, you just want time to stop. This translates to a certain amount of dread. And the funny thing is, the more you allow those interims between writing episodes to open up, the worse you feel.” Here the city lights taper into long even lines of suspension cables. I am asking you please to come across the bridge.

Finally, certain exasperation behind us, the mad dash comes. And here you have me running down the street a pace nothing short of hell-bent. My form is not pretty, but does in the heaviest handed way what I ask of it: “Finishing makes me happy. It’s like going through a full bottle of shampoo. You get to the end, and you may think ‘wow, I lived through another whole bottle of shampoo.’ You’re going through life. It’s a wonder. So you finish a paper, and you may think ‘well, that’s another sign of me on this earth!’”

It is asking a lot, this revelation, I know. But thank you for making the journey.

Toward an agenda for ubiquitous literate activity in a digital age

Whether aimed at narrative accounts or metaphoric representations, these digital video versions of literate tales feel intensely personal and yet are indexically anchored in the social and material ecologies of the day. They also produce recurring patterns and commonalities across vignettes—perhaps the product of common socialization and schooling, shared landscapes of representational conventions, the given tasks and available technologies, all further revealing the interconnecting web of ubiquitous literacies. Digital technologies may afford new means of capturing the dispersed threads of literate activity that ultimately get woven together to form a particular text, event,
object, or person, but they also open up a new opportunity space for making meaning, for reflecting upon and trying to communicate what it is we do. Working to represent (in words, images, and sound) our processes of inquiry and writing may reshape the way we experience and situate literate activity in our lives. Digital video may also afford us richer means of reflecting on such dispersed activity and what it means to our literate lives. When compared to drawings (see Prior & Shipka, 2003), the videos offer different representations of the textures of place and practice. They tend to provide a much sharper feel of affect, mood and rhythm. They are visually denser than the drawn pictures, though we hasten to note that the drawings were usually mediated by talk and gesture as writers explained their visual representations whereas the videos are composed to be stand-alone “performances.” Taken together, these reflective, representational practices (penned drawings, situated talk and gesture, video) all work in particular ways to underscore the complexity of literate encounters.

These reflections on the ubiquity of writing and learning also begin to suggest how digital media tools can extend research into literate practices. Yet, when confined to print, they fall short of communicating the richness of these representations of writers’ lived worlds. Although we have illustrated the reflections with still images culled from the videos and now arranged in the margins of the page, this print presentation suffers without a digital format. Until we have publishing venues that regularly feature digital texts alongside their print counterparts, researchers will have difficulty doing justice to the new meanings and identities that people continually assemble and re-assemble though language, literate exchange, digital media, and the “things” of everyday living.

Readings and References

The texts we cited in the opening paragraph of this chapter all highlight key dimensions of the ubiquitous nature of literate activity and literate lives. We would also note similar perspectives in rhetoric (e.g., Nystrand & Duffy, 2003), in Deweyan pragmatics (e.g., Bruce, in press), and in Bazerman’s (2007) expansive introduction to the field of Writing Studies. As in the work of the New London group, we find especially valuable those who recognize the importance of connecting literate activity with an “active, willed human process” (Cope & Kalantzis, 2000, p. 203). Other research intended to expand this line of thinking includes “Re-situating and re-mediating the canons: A cultural-historical remapping of rhetorical activity” (Prior, et al., in press), “Re-Designing Digital Literacies in the 21st Century” (Hawisher, et al., 2007), as well as recent work in the journal Computers and Composition.

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