EDUCAUSE Center for Applied Research

Research Bulletin

Volume 2004, Issue 16

August 3, 2004

M-Learning: Emergent Pedagogical and Campus Issues in the Mobile Learning Environment

Bryan Alexander, Center for Educational Technology, Middlebury College

4772 Walnut Street, Suite 206 ◆ Boulder, Colorado 80301-2538 ◆ www.educause.edu/ecar/

Overview

Mobile learning (m-learning), an educational artifact resulting from the combination of wireless and mobile computing, is stimulating a variety of changes in higher education learning environments. Student use of increasingly personalized and small computing devices exacerbates the need for instructors to multitask; increases the opportunities for cheating; and adds to information technology (IT) requirements to support multiple platforms, applications, and formats. Other phenomena, such as social swarming and the emergence of new and different learning spaces, occur at the campus level when broadscale wireless coverage is implemented.

Wiring classrooms for Internet connectivity created new opportunities for teaching and learning. Adding wireless classrooms broadens these opportunities while also bringing about new pedagogical challenges. Some say that wireless connectivity in a classroom compels instructors to choose between forbidding its usage and developing new pedagogical tactics that use students' wireless behavior to improve learning. Students receive, share, and work on content through mobile laptops and handhelds, creating new forms of collaboration and messaging as well as new demands for IT support.

Gradually, campuses are beginning to see new learning forms, with wireless connections equipping hybrid spaces with the Internet's full information powers and students arriving on campus with years of smartmobbing[1] experience. Groups of students and faculty extend their research work off-campus, using extended networks to collect information, sometimes in "augmented reality," where digital files are associated with geography.

This research bulletin examines how several campuses are addressing the new opportunities—and challenges—that mobile technologies raise, both inside and outside the classroom.

Highlights of M-Learning

As with many preceding waves of technological innovation, wireless and mobile computing bring their share of visionary discourse, utopian dreams, and dehumanizing or dystopian anxieties. These all are worth paying attention to for higher education's purposes, but it is important to understand how these technologies are actually affecting the experiences of students, faculty, and staff on our campuses. This is especially important as we develop plans for funding, selecting, and supporting them. IT departments that are already stressed by the repeated onslaught of network threats and rapidly advancing software and hardware support requirements have a special need to understand the impacts of m-learning.

Similarly, pedagogical considerations are prone to the classic utopia/dystopia whipsaw. Any transformation in our critical practices—research and teaching—strikes academics in vulnerable areas. Seeing how study and learning are impacted by new technologies is vital for reflection and policy determination. While the impact of these technologies is just

beginning to be felt, even in these early stages we can derive some principles and apply them to upcoming situations.

The M-Learning Classroom: Cases Studies and Principles

The experience of using computers that are both wirelessly connected to the Internet and easily portable, such as laptops and personal digital assistants (PDAs), is significantly and pedagogically different from that of the desktop environment. The technology is new enough in the classroom setting that it requires a creative support structure from IT organizations. The selection of an m-learning platform is predicated on the interaction of this combination of instruction and support. We will see that classroom applications are driven not by technological interest but by specific pedagogical aims—and that support is usually externally located.

Michele Forman, United States Teacher of the Year (2001), has found that today's students find a sense of intimacy with machines they hold physically close, over time, and in nonpublic spaces. Forman's high school students at Middlebury Union High School in Middlebury, Vermont, changed their writing content, using personalized computing to create more subjective compositions, a development that has curricular impact. Additionally, collaboration became more expressive and personal, as students shared machines, communicated in the same room via text messaging, and even positioned themselves and their devices to mark off a private, shared space.[2]

Structurally, this pedagogy was supported by a combination of grant funding and a shared, district-level IT staff. Forman and the IT department selected a laptop device with a full keyboard and a moderate-sized screen in order to maximize students' writing experience. Other composition applications were also available, including image- and video-editing tools.

The computer science program at the University of Minnesota, Duluth, in consultation with student government, picked the PocketPC platform to support two functions: reference materials and exercises. For the former, students use the devices as portable textbooks, easily offering information usually contained within bulkier, more expensive book forms. Faculty members can broadcast (actually serially narrowcast) new content by beaming it in class from their machines to students' machines. The PDAs are also used for quizzes and simulations, as well as for traditional applications that require spreadsheets, word processors, and Web browsers. Students appreciate the easy access to data, including preloaded multimedia content.[3]

The Duluth project, like its Middlebury counterpart, was supported by a combination of grant funding and local IT functions. Computer science graduate students and faculty wrote the exercises and additional content. Basic training was offered to teaching assistants who would be using the PDAs in large classes. Befitting Duluth's campus culture, student government played a role in determining which devices would be selected.

Beaming content was also a focus of the East Carolina University (ECU) medical program deployment of PocketPCs. In this case, students transmitted patient information

to each other through a peering technology. Because of the special security requirements related to sharing patient information, the beaming solution was preferred to networked file sharing. Users enjoyed the ready availability of data at their fingertips. Virtual keyboard and stylus-selected data entry was useful as well, especially in light of the difficulty of reading medical doctors' handwriting. Rich, secure, timely file sharing was the primary pedagogical function of this deployment of m-learning, according to the medical school's curriculum. While grant funds supported the project, ECU also set up a specific IT unit to assist in technology and pedagogy support, the Center for Wireless and Mobile Computing, which offers Web-based and face-to-face support.[4]

Although each of the preceding cases describes a classroom environment, the nature of wireless connectivity also allows mobile units to connect to the world beyond the classroom. Wireless cheating has become a noted problem in the global teaching environment and appeared at the University of Maryland, where students were able to connect with peers outside exam rooms to obtain information for tests. They used cell phones along with portable units, taking advantage of Wi-Fi connectivity. The faculty effectively caught the cheaters by posting sequences of answers to the test questions and then altering those sequences for the test itself.

Small-Scale Rollout: Middlebury College

The effects of m-learning extend beyond the classroom and into the larger learning environment. Many institutions experiment with limited deployments on a small scale, "unwiring" a single building or group of sites. Libraries, student unions, and the occasional department committed to new digital media are typical locations for such programs. Some sites are chosen for their social functions, assuming users will take advantage of convivial spaces to collaborate through technology.

Social structure—such as the desire to ease and expand access to digital content—drives campus rollouts beyond the classroom. Support, therefore, becomes a social issue, as new maintenance practices arise among users and IT staff.

Middlebury College set up limited wireless spaces in a set of classrooms and in a student union. Middlebury now plans to radiate coverage through its newly opened library.

Middlebury faculty expressed doubts about larger wireless deployments, concerned that problems and resource allocations could outweigh the minimal pedagogical advantages. Additionally, they share many instructors' concern[5] about students' multitasking and losing focus on learning. Middlebury's teacher education program explored this through practice, by supporting wireless-equipped laptops in a set of classrooms. Students were found to be multitasking, and instructors spoke of students' partial attention in class; however, perhaps because the students were education majors and were aware of the pedagogical dimension, this new form of classroom space aided instruction, with professors using shifts in students' attention as indicators of the instructor's performance.

The infrastructure issues were significant. Campus IT supported the experiment without any external assistance. Although this was sufficient for the limited deployment of the pilot program, it would not be sufficient for a large-scale rollout. One of the positive outcomes of the project was that students and instructors admired the convenient access that the combination of mobile devices and wireless networks afforded. On the other hand, battery and cabling issues emerged as problems that required social solutions—specifically, students learned to charge their machines fully before arriving in class. Devices were selected for content (primarily longitudinal student portfolio work) and mobility.

Medium-Range Deployment: Seton Hall

Beyond pilot experiments, campuses can extend wireless coverage to wider sections of a campus, short of full coverage. This affords multiple access points to connectivity, both technologically and socially.

Seton Hall chose this approach in order to meet an infrastructure and curricular need: expanding student access to Internet content. Wireless addressed the physical and cost limitations of wired connectivity. A gradual, progressive rollout occurred over several years and remains ongoing. Laptops were selected for their application power, to take full advantage of connectivity, and because they were supported by an existing grant program.[6]

M-learning increases the flexibility of learning spaces. Wireless carts reduced the reliance on fixed labs spaces at Seton Hall. Cafeterias, lounges, and outdoor spaces were transformed into learning spaces through the introduction of wireless technologies. The possibilities of new pedagogy techniques continue to be explored, as faculty members are increasingly interested in and investing their time in curricular rethinking and development.

Support has come from an existing IT department, with external assistance from IBM and AT&T. Trained undergraduate consultants have expanded IT's reach in the form of support for the new curricula and learning spaces.

Small Class Mobility Outside the Classroom: Two Cases

M-learning may also appear beyond the classroom in the form of mobile fieldwork. With handheld computers now able to perform much of the work of laptops, "computers" are increasingly mobile. Additionally, as cell phone coverage becomes nearly ubiquitous and Wi-Fi increasingly widespread, Internet connectivity can enhance mobile computing. Many faculty and students are willing to experiment with using networked mobile technologies for teaching, learning, and conducting research in the field. Interestingly, support for these projects often begins with project participants rather than with the IT organization.

The two-year Dutch GIPSY[7] project, which began in 2002, is a case in point. The project's slogan, "pick up your school and learn," signals the pedagogical power inherent in mobile research. The project's goal was to develop flexible courses unconstrained by location and time. GIPSY has conducted a series of recent experiments, using mobile

devices to support data gathering and collaboration on the fly. Student teams worked in natural settings, using handhelds to store information and observations about earth science, environmental studies, and archaeological projects.

Additionally, GIPSY has experimented with "augmented reality," the overlay of digital content on a physical location. Augmented reality is also known as location-sensitive computing. For example, GIPSY's Nijmigen Walk featured a digital representation of a Roman site superimposed on a present-day shopping area in the Dutch suburb of Nijmigen. Students, standing in a modern-day parking lot, downloaded archaeological information about their location and literally "saw" how an ancient barracks once occupied the space, and GIS data provided rich cartographic detail.

Support was provided by the intercampus GIPSY team, augmented by a grant from the SURF foundation.[8] GIPSY selected a PocketPC device to accommodate outdoor environmental challenges. Additionally, the device supported the pedagogy of collaborative teams by allowing easy file sharing and text messaging.

Research outside the class does not necessarily require student presence. The High Performance Wireless Research and Education Network (HPWREN) at the University of California, San Diego also considers the outside world a research field for automated, distant data gathering.[9] An engineering class selected small, multiple-sensing units, similar to radio frequency identification chips, and affixed them to locations on a bridge in order to test stresses over time. Each unit had a small wireless transmitter and streamed information back to campus. Working in their offices, researchers received and analyzed the data. Support for the project involved faculty and extant IT staff.

Full-Campus Cloud: Dartmouth College

Instead of a partial wireless network rollout, a campus can choose to blanket its entire area in a "wireless cloud." This anticipates a possible evolution of wireless culture, based on the rapid expansion of cell-phone ranges and the growth of Wi-Fi clouds in urban areas. With wide area wireless coverage, the social structure described for partial rollouts expands in significance, as students learn to combine their mobility with always-on information in new learning spaces and as instructors revise the old curricula.

The best-known example of such a campus cloud is at Dartmouth College, which used hundreds of wireless access points to cover its buildings, lawns, and the town of Hanover, New Hampshire, including most recently the town's river.

New learning spaces have emerged at Dartmouth, as they did at Seton Hall, mostly outdoors but also in social locations such as cafeterias. New pedagogies are also beginning to emerge. Lewis Duncan speaks of ad hoc socialization, "spontaneous communities for work and study" that form using computing and Internet access for their activities.[10]

Chris Jernstedt, professor of psychological and brain sciences, adjunct professor of community and family medicine, and director of the Center for Educational Outcomes, has developed a model of wireless feedback based on cognitive changes. Students in his classes are required to respond to certain prompts via handheld devices. Each

response is simple (true or false, a/b/c) yet requires consideration and action. Quick, simple, yet reflective responses, repeated throughout a class session, increase students' ability to retain material by establishing new neural connections.

Dartmouth faced major infrastructure challenges to support its campus cloud. The deployment has been supported by generous outside grants, along with a dynamic IT staff. Yet to be resolved are issues related to security for campus visitors and intermittent connectivity loss as users wander between access points and their zones. The campus has chosen to support multiple mobile devices. Jernstedt, for example, selected Visors for simplicity of use and deployment.[11]

What It Means to Higher Education

Although m-learning is an emergent field based on new and rapidly developing technologies, we can gather information on higher education practices, derive principles and questions, and look toward the future in a more informed manner.

Consider the evolution of computer-mediated pedagogical thinking since the introduction of the World Wide Web. In response to the Internet boom, many campuses sought to wire themselves more fully, while procuring sufficient amounts of hardware to assure student access. Pedagogies from earlier times struggled to map onto the new medium: pioneering hypertext tools like StorySpace and HyperCard were soon dwarfed by the World Wide Web. Text environments (MUDs, MOOs) became accessible from Web browsers, and collaborative writing tools evolved alongside the Web (for example, the Daedalus Integrated Writing Environment).[12] As academics learned to disentangle "Web" from "Internet" in the mid-1990s, and as younger students rapidly grew to inhabit these spaces, pedagogies expanded to cover this diverse set of network ecologies.

Cyberspace proliferated beyond any single practice as its users and content expanded, resulting in e-mail as collaborative tool, Web publishing as content-delivery mechanism, discussion applications, chat spaces, and proprietary spaces (Lotus LearningSpace[13] and the University of Phoenix[14] system). In response, wired campuses accumulated hardware. Cyberspace grew its own pedagogical expectations, sometimes moving away from the pre-Web imports. By the start of the 21st century, U.S. higher education began to distinguish pure distance learning from the blended or hybrid (face-to-face plus online) model of learning. New tools were built to capture the complex educational ecosystems, most notably in the form of course management tools and MIT's OpenCourseWare.[15] The Internet persisted in generating its own educational forms, sometimes more quickly than academics could digest them, offering the Google search engine as perhaps the most spectacular source of quick information access. Instructional design for online courses grew into a discipline, and information literacy became an approach for incorporating these diverse forces into student learning.

M-learning will likely repeat some of these patterns. While higher education faculty and administrators struggle with when to allow mobile access, students are already socializing through that very technology. Developers of course management system are

making their software handheld-friendly, and the synergy among communication, computing, and mobile technologies is enabling smartmobbing globally.

Infrastructure and support demands for m-learning are met in different ways that often involve components external to the central IT organization (local IT units, intercampus groups, grants). Across a campus, m-learning tends to develop in stages, starting with pilots and ultimately expanding to broader campus audiences. Selection of devices ranging from handhelds to laptops stems from pedagogical needs. Given the growing link between social structure and mobile technology, we should not be surprised to find that support issues are deeply socialized. Students and faculty learn how to keep machines powered, for example, and libraries seek to expand their traffic by loaning wireless units. At the extreme, m-learning is engineering social change.

So far, cell phones are not being used for data transmission in a significant way on U.S. campuses—except for cheating. However, as Wi-Fi spreads, cell phones may become platforms for off-campus information, especially as their quality and potency increases.

To some extent, technology drives social practices. For example, breakthroughs in lithium batteries enabled cell phones to be small and practical enough to use for text messaging and smartmobbing as well as for voice services. But on campus, educational goals are driving m-learning. Between expanding student feedback, improving access to digital content, opening up campus spaces to information, and setting the stage for ad hoc learning groups, campuses are entering the wireless, mobile world in order to make m-learning work for higher education's core missions of teaching and research.

Key Questions to Ask

- How can institutions best manage m-learning support in a sustainable fashion, beyond external grants and pilots?
- How should institutions recognize and support mobile learning communities, both financially and in policy terms?
- What are the best practices for collaboratively sharing information or support among institutions?
- How can institutions best support mobile learning off-campus?
- Are campus IT departments ready to support the variety of mobile hardware platforms, or should campuses focus on a narrow selection?
- How widely applicable is augmented reality, in terms of pedagogy and support?
- What networks and practices can best support collaborative learning object development for m-learning?
- Will cell phones become learning platforms, or will larger devices remain the focus of learning?

Where to Learn More

- M. Aakhus and J. Katz, eds., *Perpetual Contact* (Cambridge: Cambridge University Press, 2002).
- NLII Mobile Learning Key Theme, <http://www.educause.edu/nlii/keythemes/mobilelearning.asp>.
- H. Rheingold, *Smart Mobs: The Next Social Revolution* (New York: Perseus, 2002). Additionally, see Weblog, <http://www.smartmobs.com/index.html>.

Endnotes

1. The term "smart mob" is explained in H. Rheingold, *Smart Mobs: The Next Social Revolution* (New York: Perseus, 2002). Additionally, see Weblog, <http://www.smartmobs.com/index.html>.
2. Michele Forman, presentation and discussion, Pedagogical Implications of Wireless and Mobile Technologies Workshop, Center for Educational Technology, January 2004.
3. iPAQs at University of Minnesota Duluth, <http://www.d.umn.edu/itss/computing/ipaq/>. See also J. Allert, L. L. Deneen, and J. P. Riehl, "Pocket PCs in the Learning Environment: The UMD Experience," presentation at EDUCAUSE 2002, Atlanta, Georgia, October 1–4, 2002, <http://www.educause.edu/asp/doclib/abstract.asp?ID=EDU0253>.
4. Center for Wireless and Mobile Computing, East Carolina University, <http://www.cwmc.ecu.edu/>. See also S. Collins, J. Q. Mallette, and S. Thornton, "From Toys to Mobile Tools: PDAs in Medical School—Tackling Confidentiality," presentation at EDUCAUSE 2002, Atlanta, Georgia, October 1–4, 2002, <http://www.educause.edu/asp/doclib/abstract.asp?ID=EDU0243>.
5. J. McHugh, "Unplugged U.," *Wired Magazine*, Vol. 10, No. 10, October 2002, <http://www.wired.com/wired/archive/10.10/dartmouth.html>.
6. K. J. Higgins, "Seton Hall Network Grows Without Wires," Network Computing Web site, January 7, 2002, <http://www.networkcomputing.com/1301/1301centerfoldtext.html>. See also "From Wired to Wireless, Powerful Learning Tools for an Advanced Technology Generation," Symbol Web site, 2004, <http://www.symbol.com/solutions/education/setonhall.html>; and S. G. Landry and H. Stewart, "Mobile Computing and Technology Assessment: A Case Study with Results," poster session at EDUCAUSE 2003, Anaheim, California, November 4–7, 2003, <http://www.educause.edu/asp/doclib/abstract.asp?ID=MAC0303>.
7. The goal of GIPSY—**G**eo-information for **I**ntegrating **P**ersonal learning environments by Web and mobile ICT **SY**Stems—is to develop minimally location- and time-bound courses, <http://www.feweb.vu.nl/gis/SPINlab/education/GIPSY/GIPSYIntroduction.asp>.
8. SURF foundation, <http://www.surf.nl/home/>.
9. HPWREN Network, University of California, San Diego, <http://hpwren.ucsd.edu/>.
10. "Unleashed: The Summit on Wireless and Mobile Computing," Dartmouth College, Hanover New Hampshire, October 8–10, 2003, <http://unleashed.dartmouth.edu/>.
11. Ibid.
12. The Daedalus Group, <http://www.daedalus.com/>.

13. IBM's Lotus LearningSpace, <http://www.lotus.com/products/learnspace.nsf/wdocs/homepage>.

14. The University of Phoenix, <http://www.phoenix.edu/>.

15. MIT's OpenCourseWare, <http://ocw.mit.edu/index.html>.

Acknowledgment

The author wishes to thank his colleagues, Jamie Carroll, systems administrator and GIS specialist, and J. Scott Payne, senior lecturer in linguistics and applied language studies and assistant director for technology and research at the Center for Language Acquisition, for their work on wireless over the past two years.

About the Author

Bryan Alexander (balexan@middlebury.edu) is Co-Director of the Center for Educational Technology, Middlebury College.