S W A R M

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By Bryan Alexander

GOING NOMADIC: MOBILE LEARNING IN HIGHER EDUCATION

The combination of wireless technology and mobile computing is resulting in escalating transformations of the educational world. The question is, how are the wireless, mobile technologies affecting the learning environment, pedagogy, and campus life? To answer this question, we must assess the current state of affairs, surveying cyberculture globally and historically.[1] We must consider the United States only peripherally, since it lags behind other parts of the world in several key trends. And we must carefully examine the wireless, mobile learning experience as it rapidly develops, doing our best to grasp emergent trends.

The Contours of M-Learning

Several terms are currently being used to refer to this new learning environment. *Wireless* is perhaps the leading label, for several reasons, including its sense of the unwiring of connectivity and the implicit untethering of hardware from local cabling. The term *wireless* suffers from several weaknesses, however. First, any term that defines a negative ("less") rather than asserts a categorical positive risks vagueness and ahistoricity (as does, more famously, the term *postmodern*). Second, *wireless* underplays the mobility aspect of the new environment. *Mobile learning,* or *m-learning,* covers this point better, but this term doesn't imply wirelessness—that is, I may carry a Palm without connectivity and be mobile but not wireless. *Ubiquitous computing,* or *ubicomp,* does a better job of synthesizing these two features, describing wireless, portable, mobile, and multiple units joined in what the Dutch GIPSY Project calls a "device ecology."[2] However, the term *ubicomp* is often misunderstood. Mark Weiser's sense of *ubicomp* as naturalized computing is lost when *ubiquitous computing* refers to "lots of machines" or "decently ready access to labs."[3] Finally, none of these terms really grasp one key feature of the new milieu: the modeling of subjects as creative, communicative participants rather than as passive, reception-only consumers. We lack a term for describing the world as a writeable and readable service, encompassing mobile phones forming communities, P2P handheld gaming, moblogging, and uploading to RFID chips. For now, and to retain the educational focus, I'll use *m-learning.*

What does this world consist of? First is hardware: Mobile telephony. Laptops, increasingly wireless. Personal digital assistants, including PalmPilots and Pocket PCs. The Danger Hiptop. Tablet PCs. Handheld gaming tools, such as the N-Gage. MP3 players. Wireless connectivity detectors. Bluetooth-enabled devices. Wireless access points, which can irradiate a room or area or be knitted into a cloud covering a block, a campus, or an urban sector. Digital cameras, still and motion, which are increasingly found in cell phones. USB drives. Fusion devices,

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such as combination phone/PDA/MP3-players. RFID tags in the millions. All of these are supported by ambitious, shifting, emergent infrastructure networks of connectivity, access, and payment.

What social practices are emerging from this expanding, disruptive device ecology? The idea of *emergence* is the key rubric here as cultures grapple with and generate new device-based practices.[4] Every week produces a new twist of wireless culture, from personal spying to mobile-phone-based Bible lessons.[5] Personal surveillance is growing: the personal spying hardware market has advanced from the old X10 camera to smaller devices, and users are repurposing cell phones and other devices to snoop on spouses and employers. In American culture, speakers can curtly demand a cell phone shut-off, whereas other cultures allow energetic mobile talking and texting, even in movie theaters. More broadly, mobile and wireless computing has altered the rhythms of social time and has changed uses of social space. Cell-phone-equipped urbanites meet by triangulating fluid schedules and shifting points on the cityscape. Texting occurs within and between nearly every social situation—driving, going to the theater, attending classes—despite the abhorrently kludgey interface, adding a secondary, and sometimes socially oblique, communicative layer to everyday life. Multiple, distributed, radio-connected devices—from bridge-sensor arrays to Wal-Mart's use of RFID tags—have enabled new orders of research, information tracking, dataveillance, personal surveillance, and communication. Easy digital photography and videography have opened new frontiers in art, such as moblogging, while also affecting police-community relations, school surveillance, and spousal tensions. Integrated virtual and face-to-face communities, such as flashmobs and Hiptop Nation, have formed, as have political, artistic, and social groups, which move in smartmobs,[6] using mobile technologies to enhance their cohesion and efficacy.

Those of us in higher education have already dipped into this wave—or have felt it wash up to our knees. Japanese schools are developing policies to block cheating by SMS. Some colleges have

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considered ceasing to include lab funds in their capital campaigns because labs are being replaced by wireless lab equipment and configureable furniture. Several campuses, such as Dartmouth University and American University, have rolled out full-campus connectivity clouds. In a widely read story last year, a Texas law professor, feeling threatened by the way students were using wireless connectivity in his classroom, ostentatiously brought a ladder to class, climbed up it, and unplugged a ceiling-mounted wireless access point. Posted in the Slashdot discussion attached to its blogging of this story were many critical responses, not surprisingly, including negative reactions from teachers who had already developed pedagogies for the m-learning world.[7] In some ways, we are presently in a state resembling the early 1990s, when we were wiring up campus spaces for the first time and wondering about the new WorldWideWeb concept.

The Scales of M-Learning
To understand the scales of m-learning, let us begin by considering a basic unit of analysis: the individual student. Students work differently with m-learning devices than they do with tethered desktop computers. Public-lab computers are precisely that, no matter the temporal and emotional investment of the users, who face other people literally and informationally, through sharing and the local network. Even personally owned desktops retain an external, semipublic face,

their screens readable by passersby or, worse yet, roommates. But mobile machines become personally intimate; they are held close to the body—in a purse, on the lap, in a pocket, on the floor next to the user. Their screens are easily hidden from prying eyes. Emotional investments increase, even with shared devices. Michele Forman, the 2001 National Teacher of the Year in the United States, notes that her high school students became very attached to their wireless laptops. They significantly increased their personal writing and composition.[8] Such machines become prosthetics for information, memory, and creativity. Are we ready to respond to such attitudes from IT staff, instructors, and participants in the physical and information architectures of campus spaces?

If we scale up our view from the student to the classroom, we note subtle changes in that experience. Many of the aforementioned technologies appear by instructor intent, classroom design, or student interest, and practices of using them are emerging. Multitasking has intensified and extended as students move more easily between applications, hardware, and classroom elements, including other students and, intermittantly, the instructor. Instructors increasingly feel that they are competing with the computer-mediated world, from Google to IM, and they respond differently. Some refuse the multiplicity and, like the Texas law professor, simply cut off access entirely. A smaller, related version of this response—the practice of commanding closed machines, or "shells down"—allows instructors to separate class time cleanly and flexibly into computer-mediated and other. Some instructors seek to capture a pedagogical benefit from m-learning, using students' keyboard-attention drift as an indicator of their own engagement. At a peer level, students are using mobile computing to shape and express their collaborative intent: turning their machines away from the rest of the class to create a group subspace, or literally exchanging hardware as a platform for coauthored content, or sitting back-to-back and sharing big files electronically while talking quietly.

Let us scale up from the personal, beyond the classroom, to the campus. What

does a campus look like when students are accustomed to reaching the Internet from wherever they stand, stroll, or lounge? We may be seeing the decline of the lab and the rise of the multiconfigurable class. After all, why raise funds for another fixed-station lab when an m-learning cart can bring that capability to the classroom? One result is growing interest in mobile chairs, desks, and displays. A second result is an increase in blended or hybrid learning as Internet access and collaborative learning are enhanced by m-learning; perhaps this is becoming the default, expected form of learning. A third is the rising interest in new learning spaces such as information commons, where wireless, mobile connectivity admits the full informatic range of the Internet into any niche or conversation. Older spaces take on new pedagogical meaning; for example, wireless cafes allow the full range of classwork to be deployed between a coffee and a bagel. Moreover, since this technology is mobile, students turn "nomad," carrying

conversations and thinking across campus spaces, as always, but now with the ability to google a professor's term, upload a comment to a class board, and check for updates to today's third assignment—all while striding across the quad.

Research also changes with this technology, as students and faculty can place networked sensors on campus or in the nearby community to track usage of social space, urbanization, or microclimates. Data can be streamed to mobile units and/or to student and faculty desktops. Images can be captured and uploaded to the Web through mobile weblogs (moblogs). For example, a team from Umeå University in Sweden moblogged Jokkmokk's 399th Annual Sámi Winter Market. Students applied their academic learning about the Sámi to the real world, interviewing participants, conducting follow-up digital research on the fly, and uploading and expanding on commentary online (http://blog. humlab.umu.se/jokkmokk2004/). In other (theoretical) examples, student

teams could explore an aboretum, taking digital photographs of plants, editing and annotating the images, and uploading them to a campus forum while IMing with other students elsewhere in the greenery; researchers could deploy multiple, intercommunicating sensors on objects of study, then sift the information in real time from their offices or coffeeshops, discussing results with students or experts elsewhere in the world; interns and social science majors could fan across a community, more readily recording and sharing information than before. Town/gown relations grow to yet another level of complexity.

Emergent Cultural Trends
Let us consider, once more, that students come from the smartmobbing world. Examples are plentiful in popular journalism and also, increasingly, in the blogosphere.

■ *A datapoint on texting, from Great Britain:* "A massive 20.5 billion SMS messages
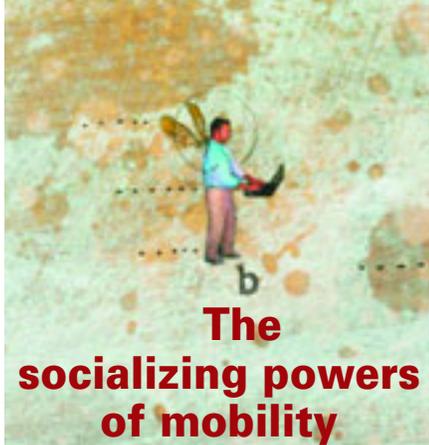
The socializing powers of mobility and wirelessness could expand the drive into collaboration.

were sent over the four main mobile networks, said the Mobile Data Association, with 1.9 billion sent in December [2003] alone. That compared with 16.8 billion the previous year."[9]

■ *A datapoint on information on demand, from Scandinavia:* "BioWAP facilitates searching information from all the major nucleotide and protein sequence databases, as well as study structural information and mutation data related to immunodeficiencies. With BioWAP it is possible to search for general properties of sequences, user-defined patterns and restriction enzyme recognition sites."[10]

■ *A datapoint on cameras, from Japan:* "Nikkei BP Consulting Inc recently revealed the results of a survey on cell phone usage among Japanese primary and junior high school children. It shows that among Japanese girls using cellular phones or personal handyphone systems (PHSs), 72.7% of their phones had cameras. Out of junior high school students, 30% took their cellular phone or PHS to school, and spent 3,000 yen average a month for data transmission. The survey covers some 200 Japanese mothers and their daughters, from grade 5 of primary school to grade 3 of junior high school, or from 11 to 15 years old. All the girls live in or around Tokyo or Osaka urban areas, and have a mobile phone or a PHS for their own use."[11]

The flashmob craze from the summer of 2003, the ubiquity of cell phones among teenagers, the well-known technological familiarity of kids—this generation entering our schools is immersed in cyberculture and is untethered, mobile, and wirelessly connected.

But where is the pedagogical and scholarly potential? In one sense, all that is new is old again. We already know this world of informatics everywhere: books, papers, conversational niches, discussions for learning potentially everywhere in our spaces. That's one definition of a campus, in fact, and is what makes a campus different from other places. In this sense, m-learning is conservative in the best sense and can be viewed as deepening higher education's connections to its roots.

On the other hand, consider that all the informational and communicative power of what the National Science Foundation calls *cyberinfrastructure*[12] is available to any m-learner, at any point in space and time. If this is where learning will happen, then new forms of learning are emerging around us. The IT and infrastructure demands are clear. At the same time, information literacy may change as students expand their multitasking, mobile, learning-on-demand ethos.

One example of an emergent trend is *swarming.* In their book *Swarming and the Future of Conflict,* John Arquilla and David Ronfeldt describe a difference in social formation between armies with strong command-and-control structures and those with distributed operations in which units disperse, fade into everyday life, and then suddenly appear and converge on a target, either by prearranged signal or by opportunity shared by information peering. Although swarming dates back to Napoleonic and even Mongol armies, wireless and mobile technologies have enabled a variety of social groups to swarm effectively.[13] The "Battle for Seattle" in 1999 saw protesters swarm in order to successful evade police control. The Philippine president Joseph Estrada was brought down by a rapidly swarmed protest in Manila in 2000.[14] During the spring of 2003, antiwar protesters around the world showed how to effectively disperse and re-form at new points. Flashmobs instanced swarming, as did Al-Qaeda in 2000 and 2001, street-

gangs and mobs in the United States, Columbia, and Mexico for several years, and Japanese urban youth. All show this form's power to move within an adversary's decision cycle, then fade away once more. Are we in higher education ready to respond to students capable of forming into groups this rapidly and with such precision? Do we know how to take advantage of this tactic? Social software, such as Meetup, has been developed partly to coordinate such social groups. Are we fluent in social software? Do we know how to assess it for its applicability to our pedagogical and campus needs?

Perhaps we are beginning to see the emergence of *learning swarms.* We already know the precursors, in the form of interested learners who appear at campus libraries and museums, driven by an experience that excited them, such as a film, a book, or a conversation. Now the socializing powers of mobility and wirelessness could expand this drive into collaboration. An interested learner could ping a network or site for learning engagement: digital objects, digitally tagged materials, learning objects, instructors, other learners and instigators. We've seen a part of this in the global, collaborative use of MIT's OpenCourseWare. Are instructors ready to join in learning swarms on their specialties or to facilitate the ad hoc growth and flourishing of such learning swarms? Can we integrate these into our "less swarmy" campus environment? Are we ready to advise students and staff about appropriate devices to use ad hoc, and are we prepared to learn from experience? Imagine being able to support and feed interests from members of our community: building a brief enthusiasm into a larger learning moment, linking students to each other in the spirit of intellectual curiosity, and knitting the campus community even more closely together. For example, suppose a first-year student sees the recent film *Master and Commander* and becomes interested in the world of eighteenth-century sailing. With no guidance, the student might hit Amazon.com for other novels by Patrick O'Brian, watch a History Channel program about sailing, or conduct a Google search and find a few related Web pages. Or instead, the college could set up an environment in which the student finds that one history professor

regularly teaches "the great age of sail" in several classes, has Web pages on the 1790s naval wars, and might answer an e-mail or office-hours query; that the library has digital and print resources ready at hand; that several other students share this curiosity and chat about it with IM; and that a staff member sailed on a rebuilt eighteenth-century vessel last summer and would be delighted to discuss the experience.

Such moments might be brief—hardly a new thing in the world of education. Borrowing a leaf from the political concept of Hakim Bey's book *Temporary Autonomous Zone,* we could think of *temporary* learning zones, swarms, or experiences.[15] These can be very meaningful and positive in memory, or they can play a building-block role in subsequent learning, or they can do both. How should our institutions approach thinking about this possibility? Are we ready to sense which of our students arrive at our campuses with such experiences already under their belts? How do nomadic swarms work with our anthropologically sedentary campuses?

Another example of an emergent trend involves digitally tagged objects. Part of the promise of cyberspace was the abolition or transcendence of space, a promise that drew on similar rhetoric for previous electrical technologies, from the telegraph to the television. Developing in parallel with this movement, however, is the concept of identifying digital materials with specific physical locations. The geolocation abilities of GPS (Global Positioning System) technologies, first deployed to powerful effect during the Persian Gulf War of 1991, are well known. Less known, so far, is the development of applications using this pattern creatively and socially. In a 1999 article "Information in Places," the computer scientist J. C. Spohrer argued for locating digital documents in networked grids that correspond to real-world spaces.[16] A three-dimensional matrix mapped onto one-meter intervals could be accessible for uploading and downloading by wireless, mobile computers. Thus, in an office building, a user could copy a note to another user's door, for example, or could access files cued to their physical

presence in a conference room. "Information in Places" is ambitious, extending this paradigm out of the office and across cities. Imagine walking into a park covered by such a grid and glimpsing a plant you don't recognize. You could post a note to that grid-point from your cell phone, perhaps with your e-mail address attached, and then check back over time to see who uploaded a reply. Spohrer's vision goes further, extending around the globe and culminating in what he dubs the WorldBoard, an infrastructure that would let us consider the human layer of the earth as one vast downloadable, writeable, searchable surface.

The better-known term for this idea is *augmented reality*, and it is already in practice. The geolocation of Web documents has been proceeding energetically over the past year, with metadata and Web services applications. For example, the "34 North 118 West" Project lets users experience a story by physically exploring a city space, using GPS-equipped Tablet PCs to pull down pieces of a larger, multilinear, multimedia narrative (http://34n118w .net/). The Dutch GIPSY Project has an "Archaeological Walk in Nijmegen," where students physically stride among the PDA-displayed digital documents of Roman buildings, mapped onto their present-day corresponding suburban buildings (http://www.geo-informatie .nl/amc2_rsgis/posters2003/poster_gr3 .pdf). Pop-up windows on the location-aware computers describe what was once where the user stands, with hyperlinks to contextual information and discussion. Imagine versions of this for urban history and design. On a campus, the physical site could be augmented with digital records of college history, tour information, and campus digital life. Consider the manifold implications for intellectual property (recall ThirdVoice and EQuill). Who owns the data pasted over someone else's property? Will the copyright wars open up a new front in augmented reality? How will access shape up, with digitally walled gardens superimposed on their physical versions? Closer to home, are campuses ready to think about such gridded, interactive clouds on their premises?

The physical vs. the digital, the sedentary vs. the nomadic—the wireless, mo-
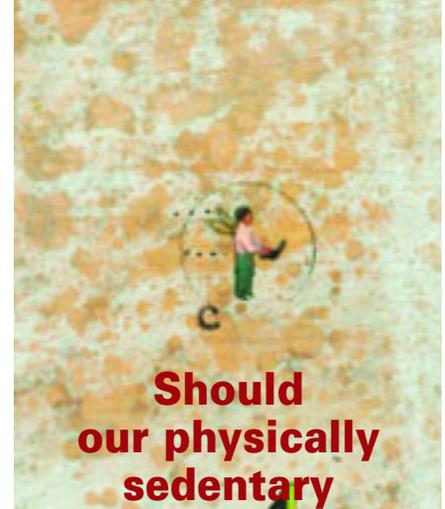
Should our physically sedentary campuses embrace the digitally nomadic swarms of arriving students?

bile, student-owned learning impulse cuts across our institutional sectors, silos, and expertise-propagation structures. How do we respond to such across-the-grain learning? Is this a budding venue for curricular transformation, wedding student interest to institutional practice? Gilles Deleuze and Felix Guattari wrote powerfully to this problem in their 1980 book *Mille plateaux*.[17] There they explored the tensions, overlaps, and complementarities between conceptually nomadic social organizations and sedentary ones, developing differences along lines of cultural rhythms, the construction of authority, the use of landscapes, and the built environment. How prepared are we in higher education to cope with, or take advantage of, these deeply rooted differences? Should our physically sedentary campuses embrace the digitally nomadic swarms of arriving students?

I am reminded of Franz Kafka's "An Old Manuscript," an account of a nomadic army arriving in an imperial city.[18] The nomads arrive suddenly, surprising the urban population and appearing without warning in city streets, markets, libraries, and homes. Kafka's tale focuses on the incomprehension of the city-dwellers, as well as on their dogged willingness to attempt living life as if the nomads simply weren't there. The story charts their progressive decay and their slipping grasp on reality while the no-

mads build a new civilization literally in their front yard. It's a very funny story, in Kafka's unique way, but of course it's also a cautionary tale, especially for those of us in higher education. At colleges and universities around the world, the nomadic swarms are already arriving. *e*

Notes
1. For more on cyberculture, see the Web site for the Resource Center for Cyberculture Studies (RCCS): <http://www.com.washington.edu/rccs/>.
2. Petra Wentzel, "Wireless All the Way: Users' Feedback on Education through Online PDAs" (presentation at the EDUCAUSE annual conference, Anaheim, Calif., November 7, 2003).
3. Mark Weiser, "The Computer for the 21st Century," *Scientific American*, vol. 265, no. 3 (September 1991): 94-104, draft copy available at <http://www.ubiq.com/hypertext/weiser/SciAmDraft3.html>.
4. For more on the idea of emergence, see Steven Johnson, *Emergence: The Connected Lives of Ants, Brains, Cities, and Software* (New York: Scribner, 2001).
5. "Russia Launches the First Bible SMS-School," *Pravda*, January 12, 2004, <http://english.pravda.ru/main/18/90/363/11765_phone.html>.
6. The term *smartmobs* is not one of automatic apprehension. Howard Rheingold, *Smart Mobs: The Next Social Revolution* (Cambridge, Mass.: Perseus, 2002), points out that some smartmobs aren't smart and that social cooperation is not always beneficial. The etymologically minded will recall that in American English, *smart* has two additional meanings, which are relevant here: to offer criticism, often sarcastic; and to suffer pain.
7. Lisa Guernsey, "In the Lecture Hall, a Geek Chorus," *New York Times*, July 24, 2003, <http://www.nytimes.com/2003/07/24/technology/circuits/24mess.html>; "Lecture Hall Back-Channeling," Slashdot post and discussion, July 24, 2003, et seq., <http://science.slashdot.org/articles/03/07/24/1347242.shtml?tid=146&tid=99>.
8. "Pedagogical Implications of Wireless Technologies," workshop, Center for Educational Technology, Middlebury College, January 14, 2004.
9. "Text Messaging Reaches New High," *BBC News*, January 23, 2004, <http://news.bbc.co.uk/2/hi/technology/3422475.stm>.
10. "BioWAP Service," IMT Bioinformatics Web site, <http://bioinf.uta.fi/courses/WappaW/BioWAP.html>.
11. "Japanese School Girls Prefer Cell Phone with Camera," *NE Asia Online*, December 31, 2003, <http://neasia.nikkeibp.com/wcs/leaf?CID=onair/asabt/resch/283081>.
12. See Report of the National Science Foundation Blue-Ribbon Advisory Panel on Cyberinfrastructure, "Revolutionizing Science and Engineering through Cyber-infrastructure," January 2003, <http://www.communitytechnology.org/nsf_ci_report/>.
13. John Arquilla and David Ronfeldt, *Swarming and the Future of Conflict* (Santa Monica, Calif.: RAND, 2000).
14. Rheingold, *Smart Mobs.*
15. Hakim Bey, *T.A.Z.: The Temporary Autonomous Zone, Ontological Anarchy, Poetic Terrorism* (Brooklyn, N.Y.: Autonomedia, 1985), <http://www.hermetic.com/bey/taz_cont.html>.
16. J. C. Spohrer, "Information in Places," *IBM Systems Journal*, vol. 38, no. 4 (1999), <http://www.research.ibm.com/journal/sj/384/spohrer.html>.
17. Gilles Deleuze and Félix Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia*, trans. Brian Massumi (Minneapolis: University of Minnesota Press, 1987), originally published as *Mille plateaux* (Paris : Éditions de minuit, 1980).
18. Franz Kafka, "An Old Manuscript," in *The Complete Stories*, ed. Nahum N. Glatzer (New York: Schocken, 1971).

RELATED RESOURCE

e The EDUCAUSE 2004 Annual Conference, scheduled for October 19–22 in Denver, Colorado (http:// www.educause.edu/ conference/annual/2004/), will offer sessions on the "mobile campus" and "mobile education." For examples of how several campuses are addressing the new opportunities—and challenges—raised by mobile technologies, both inside and outside the classroom, see Bryan Alexander, "M-Learning: Emergent Pedagogical and Campus Issues in the Mobile Learning Environment," *EDUCAUSE Center for Applied Research Bulletin*, vol. 2004, no. 16 (August 2004), a publication of ECAR (http:// www .educause.edu/ecar/).