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A Brief Guide to Mobile Educational Resources

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The landscape of knowledge is shifting dramatically. As Jimm Meloy, co-author of *Renaissance eLearning*, is wont to say, "knowledge workers today are (by definition) *mobile* – they don't sit at their desk anymore."[i] As a result the technologies associated with mobile communications are beginning to shape the way knowledge and information resources are designed and delivered. In this guide I would like to touch on what I find to be the more interesting precedents and current practices associated with mobile knowledge and learning as background to what might emerge as opportunities for mobile educational resources.

The range of participants, media, and devices involved in mobile information has expanded dramatically in the recent years. Personal computing devices have gone from transportable, portable, laptop, and notebook to handhelds and are integrated in a variety of fashions to cellular phones (whether by being plugged into them to obtain Internet access or being one, as with many popular personal digital assistants {PDAs}). The information available through them includes point-to-point or conferenced conversations, email, Instant Messaging, Short Message Service, synchronous chat, Internet browsing, location-aware mobile social software (MoSoSo), text, audio, and video downloads, streaming information feeds, and even live television. New standards, such as DVB-H (Digital Video Broadcasting-Handheld) are emerging to keep production standards current with those of fixed devices. Commercial carriers are not alone in packaging services targeted at particular demographics such as knowledge workers of a certain age or young professionals. The value of the offering is in the convenience of getting to the most frequently used services; access is but a wholesale component. The distinctions between cell phone and handheld computer and PDA are beginning to blur. As more than one pundit has pointed out, with video and Flash (Lite) coming to cell phones, much of what computers were relied on for is now available from cell carriers.[ii] As entire cities plan on wireless networks, the means by which folks go mobile is likely to include both Wi-Fi (Wireless Fidelity) and cellular on any given day and, perhaps, any given device.

Efforts to anticipate this evolution and understand its potential and implications for learning began years ago. In 1992, in an effort to provide a compelling vision to legislators of why a portion of bandwidth should be set aside for public use rather than auctioned off to commercial carriers for metered service, the Advanced Technology Group at Apple Computer initiated a mobile science project, "Wireless Coyote," in which science students at Orange Grove Middle School in Tucson, Arizona, engaged in a field trip to map certain environmental characteristics of Sabina Canyon. Armed with state of the shelf mobile devices such as walkie-talkies and GPS locators, as well as systems cobbled together to anticipate an environment common and widespread today such as GRiD Pads (early tablet computers) duct-taped to RF modems, the students probed and captured data as different as plant species and soil salinity. Throughout the experiment students were in communication with each other and with a base camp where their science teacher was helping coordinate and elucidate their efforts.[iii]

Contrast that day in the life of middle-schoolers with the massive adult participation in solving a mystery a decade later. In 2004, over a three month period, a viral marketing campaign designed to generate interest in the launch of Microsoft's new videogame for

the Xbox, “Halo 2,” reached new heights both for participation and for sales. The $125M spent by consumers on the new game on 9 November is still the single greatest one-day media buy in history. The fascination with the campaign’s website, www.ilovebees.com, by some two million observers of the game is not so startling as is the active participation of over a half million players who spent two or more hours a day engaged in the collaborative problem solving that the mechanic of this alternate reality game (ARG) demanded of them. In some ways an extended interactive version of the Mercury Players “War of the Worlds” broadcast, players were called upon to locate public phone booths by their GPS coordinates, ensure that someone could be there to take a call at a designated time, find a secret code that was posted on the web simultaneous to the placing of a call to that booth, supply that code to the person waiting to take that call, give the code on answering, record the message provided, and post that to the web where it could be woven together with the other pieces of the solution to the mystery. Three puppet masters worked around the clock to change the parameters of the puzzle to ensure that no one person or group of people could by him/her or themselves solve the puzzle without coordinating with the rest of the population of players.[iv] This activity was entirely supported by consumer information and communication devices.

A typical college class of today is attended by students with laptops connected to the Internet through a wireless connection available in the class. Through that connection students can validate assertions made from the podium or the chair by the professor, follow up on items offered in the lecture or discussion by researching them further in real time, contribute to a collective journal of the proceedings, carry on a critical conversation with other students in the class about the matters being discussed, record and even broadcast the proceedings, read the course assignments, and, of course, engage in any of the online equivalents of daydreaming or thinking about other things by emailing, instant messaging, chatting, working on some other course, or surfing the net for something amusing, even watching streaming or downloaded videos. Those faculty and academic administrators who insist on blacking out classrooms clearly feel the value of the collaborative learning activities in which students routinely engage are less important that the potential of anything proving more interesting to the student that what is being broadcast from the teacher.

By contrast, most computer use in K12 schools is still constrained to the library and computer lab which offers restricted access to the Internet. Productivity tools and educational applications have become commonplace, and the Internet is a reference collection the utility of which is becoming widely recognized but is also a cause of enormous concern to those who feel “media” or “information” illiteracy, students’ inability to evaluate the results of their searches, is a bigger problem in public education than the “digital divide,” the inequality of access to information resources. Despite a long tradition of “one-to-one” computing efforts coming out of vendors such as Apple and Dell, researchers such as Seymour Papert,[v] or consortia such as Project Inkwell[vi], large scale efforts such as the Maine Learning Technology Initiative (MLTI) continue to be the exception rather than the rule.[vii] The recent setback for Cobb County, Tennessee, in which a suit was brought against the district to prevent them from putting into operation a plan for one-to-one computing that was the culmination of an elaborate RFP process

because the funds were ear-marked for replacement equipment, not a new computing paradigm, is likely to have a chilling effect on K12 educators for some time to come.[viii]

In spite of slow progress and setbacks on the K12 laptop front, formal knowledge activities are becoming increasingly mobile. As one report succinctly stated it, "Mobile learning is an emergent paradigm in a state of intense development fuelled by the confluence of three technological streams, ambient computing power, ambient communication and development of intelligent user interfaces."[ix] In addition to a myriad of projects centered on mobility and learning worldwide,[x] MOBIlearn, the joint US/EU/Australian project is dedicated to the innovative use of mobile environments to meet learners' needs, and has been working not only on design guidelines but also an Open Mobile Access Abstract Framework (OMAF) that would be interoperable by OKI and IMG-GLC standards.[xi]

Nicholas Negroponte's famous paradox of the 90's (THEN: telephone through the ground, TV through the air; NOW: telephone through the air [cellular], TV through the ground [cable]) now seems to account for a much simpler world of communication. As the MOBIlearn project describes the current convergence, "Advances in computer technology, intelligent user interfaces, context modeling applications and recent developments in the field of wireless communications, including Wi-Fi, Bluetooth, multi-hop wireless LAN and the global wireless technologies such as GPS, GSM, GPRS, 3G [see "Lexicon" at the end of this guide] and satellite systems have created a wide array of new possibilities for technology users."[xii] The technology infrastructure associated with mobile knowledge is evolving and the balance of bandwidth between wireless and cellular technologies in the future, for example, is unclear even to those most interested in it.[xiii]

With respect to the challenge and opportunity for learning, the MOBIlearn guidelines define them as follows, "Any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies.[xiv]

Domestically, and with respect to youth, cell phones are currently the dominant mobile technology. Over half our youth today carry one, according to a recent study.[xv] This sort of penetration was presaged years ago by patterns of usage in Japan, where Short Message Service (SMS) texting became a basic medium of communication among a new generation.[xvi] The inveterate list maker, Mark Prensky, catalogues what he imagines you can learn with a cell phone using its various media, features, and technology:

- Voice: language lessons (e.g., English, Japanese) using mobile flash cards, dictionary and phrase book software; guided tours; examinations; suggests cell-phone-delivered lectures, with feedback facilities.
- Short Text Messages: quizzes, games, tests and test-preparation, opinion polling, classroom discussion, tutoring; suggests providing more extensive data for analysis, and response.
- Graphic Displays: literature, instructional texts, animations.

- Downloadable Programs: tools for collaboration; teaching programs; fax senders; programming languages; access to other devices.
- Internet Browsers: basic online reference tools; search engines.
- Photography: data collection and documentation; visual journalism; creative writing stimulus.
- Video clips: TV journalism; creative movie-making; suggests behavior-modeling clips.
- Global Positioning Systems: field trips; multiplayer search games.[xvii]

Martin Owen, the Director of Learning at NESTA Futurelab in the UK lists among his candidates for "killer apps" for mobile phones from an educator's point of view. "The ability of students to record and capture multimedia information at any time … The portability of the phone gives rise to other possibilities – specifically location-based services … low fidelity augmented reality – overlaying space with digital information about the space. The social and educational applications in this space are almost endless. Adding the personal and the inter-personal communication makes the proposition stronger. … In the end for me the phone is a social technology, which is why people want them. Having a media machine in the same case is convenient. … I think when we enhance the social functions of the phone with media we may find applications that people discover they want from their phone rather than their pocket TV."[xviii]

In higher education things have come a long way slowly since Dartmouth College required all incoming freshman to buy a Macintosh and the Harvard Business School required entering students to buy an IBM portable computer in the mid-80's. Two decades later, in 2004, Duke gave all its incoming freshmen iPods.[xix] It seems probable that the changes likely to accompany this generation of technology and students will be at a sharper pace. The most recent *Horizon Report* from the New Media Consortium (NMC) and the EDUCAUSE Learning Initiative (ELI) considers "personal broadcasting" to be one of two technologies slated for widespread adoption in the coming year, and the delivery of educational content and services to cell phones "just around the corner."[xx]

As Ellen Wagner of MacroMedia put it in an article last year for the *EDUCAUSE Review*, "The heightened interest in mobile possibilities for teaching, learning, and research can be attributed to a number of factors: the continuing expansion of broadband wireless networks; the explosion of power and capacity of the next generation of cellular telephones; and the fact that mobile telephones, a familiar tool for communications, are already fully ingrained in contemporary life as part of our social practice. In other words, unlike most other mobile devices used in education, devices such as PDAs or tablet computers, there is very little extra effort required to get people to adopt and use mobile phones. Rather, people can be offered more things to do with the mobile phones to which they are already attached and with which they are already reasonably competent."[xxi]

Wagner's observation about why phones may be the technology of choice for mobile knowledge and learning resonates with observations on the culture that has been immersed in its use the longest. In his review of Mimi Ito, et.al.'s new book from MIT Press, *Personal, Portable, Pedestrian: Mobile Phones in Japanese Life*, Xeni Jardin

quotes the college kid who says to the professor of his cell phone (*keitai*, "something you carry with you"), "A lifestyle with *keitai* is so natural that one without (it), or one from which (it) is taken away, sounds unreal."[xxii] An SRI International study funded by Palm, Inc., found the portable and personal qualities of PDA's to be key, and observed as well how they fostered collaboration. As one teacher testified, "The handheld computer is a truly personal computing device that is useful anywhere. The students can use the handheld anywhere, [and] with a [portable] keyboard, they have a powerful tool that they can use to get some serious work done in a wide variety of places;" another observed, "When students used handhelds, I saw greater student autonomy and accountability toward assignments and a greater sense of [student-teacher] partnership in learning together." [xxiii]

In its simplest form, mobile knowledge is select, capture, and carry – listening to this morning's chemistry lecture on an iPod at the gym. In his white paper on podcasting and VODcasting (video-on-demand), Peter Meng compares these forms of expression to the PVR because of the "time-shifting" aspect and predicts, "The rapid evolution of audio-photo-video recording capabilities through phones and inexpensive hand-held devices will create a flood of multimedia content. They will be immediately adopted by the current class of students and will be looked at with disinterest or uncertainty by many of the current faculty".[xxiv]

In perhaps its most complex form, mobile knowledge comprises large groups of participants collaborating in real time to create collective solutions with technology that knows where they are and helps them find, communicate, and create what they need. In the near term, the courses and collections that are being created for open access and the repositories that are being made more widely available would move toward becoming a more integral part of the evolution of mobile knowledge by ensuring their content was more visible, more community, and more portable: "more visible" by emerging from the "dark web" to the surface of searchable information; "more community" in the sense of metagging and folksonomies and other systems like education standards; and, "more portable" by virtue of being available in formats emerging as (MP3, video iPod format, DVB-H).

Two examples of note among the most recent effort to make education resources mobile and, at least in part, open, are *iTunes U* and investigations by the National Repository of Online Courses (NROC). The *iTunes U* initiative finally announced by Apple late last month is an industry/education collaboration to make education resources, including open education resources, available as "podcasts," that is, downloadable streams of audio and video using the standard compression format most widely carried on Apple's iPod devices.[xxv] Of all the campuses contributing perhaps the most visible has been Stanford University, by virtue of the fact that, co-sponsored by the Stanford Alumni Association, "Stanford on iTunes" has publicly accessible, "university-related audio" content, lectures and events not reserved to matriculated students such as comments on meditation and teaching by His Holiness, the 14th Dalai Lama.[xxvi] Stanford has a long tradition of capturing lectures in both audio and video and re-broadcasting them for on-campus and remote (e.g., Silicon Valley corporations) matriculated students. The only change

required for this effort is, in effect, to re-format the content to the MPEG-4 audio compression standard preferred by iTunes players, including the various sized iPods, and upload it to the collection.

NROC has undertaken a technical evaluation of the current and next generation data networks and mobile devices in order to determine how best to make the multimedia content in their collection available to mobile devices. Data network bandwidth, compression algorithm lossiness, and screen size and resolution are the constraints that have to be accommodated. Brian Rowlett, Director of Software Development and Technology at the Monterey Institute for Technology and Education (MITE) reports that networks with reasonable bandwidth (3G at 384kb/sec)[xxvii] are being put in place by at least two major carriers North American carriers (Verizon and Cingular/ATT) and that an increasing number of mobile devices are supporting that data network, including laptops, PDAs, and cell phones. That data rate allows for the downloading and even streaming of high-production value multimedia content from courses currently in NROC at a factor of ten compression. The media are most effective when they involve movies or slide shows illustrating lectures, but works also with illustrations and animations. In addition the re-formatting mentioned in reference to Stanford on iTunes, some re-editing might be necessary to make text more viable or to turn some movies into slide shows.

There are other experiments going on locally. Stimulated in part by the phenomenon of Japanese commuters reading books on their cell phones,[xxviii] a team at the Stanford Persuasive Technology Lab is experimenting with streaming text to cell phones.[xxix] Pat Suppes and Ron Fortune who collaborated at Computer Curriculum Corporation have teamed up again in Edumetrics Learning to offer the fruits of the research done at the Education Program for Gifted Youth (EPGY) at Stanford to offer instructional software, including "Mobilemath course, the first comprehensive research-based instructional system to run on handheld computers … a cost-effective platform that every student can have and use anytime or anyplace."[xxx]

In sum, there is a rich tradition of research and development associated with the use of mobile technologies for learning, and a plethora of exemplary projects and experiments currently worldwide. Open educational resources are already being made available for mobile learning, and with platforms and tools being put in place (a podcasting platform for Sakai is well under way) it can be anticipated that more will be done more efficiently. It can only be hoped that such efforts target consumer devices and exploit their communication capability in order to build a broader community of those who learn from such resources and to foster their ability to support each others' learning.

A MOBILE AND WIRELESS TECHNOLOGY LEXICON (from Ellen D. Wagner, *Op.cit.*)

The mobile and wireless landscape is filled with many acronyms and new expressions. The following descriptions are provided so that nontechnical stakeholders of mobile learning can better understand the technical and industry-specific terms that are likely to be encountered. Please refer to the following Web links for more complete descriptions of the terms noted below: <http://en.wikipedia.org/wiki/>; <http://kropla.com/mobilephones.htm>; <http://www.w2forum.com>.

2G: second-generation mobile telephone technology. 2G cannot normally transfer data, such as e-mail or software, other than the digital voice call itself and other basic data such as time and date, although **SMS** messaging is available for data transmission for some standards. 2G services are frequently referred as Personal Communications Service (PCS) in the United States. 2G technologies are either **TDMA**-based or **CDMA**-based standards, depending on the type of multiplexing used for signal exchange.

2.5G: *See* **General Packet Radio Service (GPRS).**

3G: third-generation mobile telephone technology. The services associated with 3G provide the ability to transfer both voice data (such as making a telephone call) and non-voice data (such as downloading information, exchanging e-mail, and **instant messaging**).

4G: fourth-generation mobile telephone technology. When implemented, 4G will be the successor to **3G.** It will feature high-speed mobile wireless access with a very high data transmission speed, of the same order of magnitude as a local area network connection (10 Mbits/s and up). It also addresses the notion of pervasive networks, an entirely hypothetical concept in which the user can be simultaneously connected to several wireless access technologies and can seamlessly move between them.

802.11: the official designation for the wireless protocol known as **Wi-Fi**. Short for "wireless fidelity," Wi-Fi denotes a set of wireless LAN standards developed by working group 11 of the IEEE LAN/MAN Standards Committee (IEEE 802). The term is also used to refer to the original 802.11, which is now sometimes called "802.11legacy." The 802.11 family currently includes six over-the-air standards that all use the same wireless internet protocol. 802.11b was the first widely accepted wireless networking standard, followed by 802.11a and 802.11g.

Bluetooth: an industrial specification for wireless personal area networks (*see* **PAN**) using radio frequencies to link enabled devices.

Code Division Multiple Access (CDMA): a rival to the **TDMA** standard in the Americas, this standard was developed by QualComm, from which providers must license its use. CDMA carriers in the United States include Sprint PCS (which started as a **GSM** carrier), Alltel, and Verizon.

Enhanced Data rates for Global Evolution (EDGE): a digital mobile phone technology that acts as a bolt-on enhancement to **2G** and **GPRS** networks. This technology operates in both **TDMA** and **GSM** networks. EDGE is a superset to **GPRS** and can function on any network with **GPRS** deployed on it (provided the carrier implements the necessary upgrades).

General Packet Radio Service (GPRS): a mobile data service available to users of **GSM** mobile phones. It is often described as "2.5G"—that is, a technology between the second generation (**2G**) and third generation (**3G**) of mobile telephony. It provides moderate speed data transfer, high-speed

"always on" data connections that are much faster than the traditional 9600 bps, by using unused **TDMA** channels in the **GSM** network.

Global Positioning System (**GPS):** a satellite navigation system used for determining one's precise location and providing a highly accurate time reference almost anywhere on earth. GPS is controlled by the U.S. Department of Defense and can be used by anyone, free of charge.

Global System for Mobile-telephones (GSM): the most commonly used cell phone standard in the world. GSM systems are used in nearly two hundred countries, with six hundred million subscribers worldwide. It originated in Europe and can now be found in Africa, Asia, Australia, and North America. Originally utilizing the 900 MHz spectrum, GSM providers in parts of Europe, Africa, and Asia later added additional capacity at 1800 MHz. In North America, GSM service is currently available only at 1900 MHz. Most cell phone manufacturers offer dual-band (900 and 1900 Mhz) or tri-band (900, 1800, and 1900 Mhz) phones that will work in most places GSM systems are found.

Instant messaging (IM): a client that hooks up a user to an instant messaging service. Instant messaging differs from e-mail in that conversations happen in real time. Most services offer a "presence awareness" feature, indicating whether people on one's list of contacts are currently online and available to chat. Generally, both parties in the conversation see each line of text right after it is typed (line by line), thus making it more like a telephone conversation than exchanging letters.

Integrated Dispatch Enhanced Network (iDEN): a hybrid of **TDMA** digital cell phone and two-way radio. Providers are limited (e.g., NEXTEL in the United States). Phone equipment is produced exclusively by Motorola, the company that created the standard by blending its historic experience with handheld radios with its expertise in cellular technology.

MP3: an audio compression format capable of a great reduction in the amount of data required to reproduce audio while sounding like a faithful reproduction of the original uncompressed audio to most listeners.

Multimedia Messaging System (MMS): the successor to **SMS,** this enables subscribers to compose and send messages with one or more multimedia (digital photos, audio, video) parts. Mobile phones with built-in or attached cameras, or with built-in **MP3** players, are very likely to also have an MMS messaging client—a software program that interacts with the mobile subscriber to compose, address, send, receive, and view MMS messages.

Opera: a cross-platform Internet software suite consisting of a Web browser, e-mail/news client, address book, news-feed reader, IRC chat client, and download manager. Its core layout engine is licensed by business partners Macromedia for previewing Web pages and Dreamweaver. Opera has gained a leading role in browsers for smartphones and PDAs with its Small Screen Rendering technology.

Personal Area Network (**PAN**): a network for communication among computer devices (including telephones and personal digital assistants) close to one person, where the devices may or may not belong to the person in question. The reach of a PAN is typically a few meters. PANs can be used for communication among the personal devices themselves (intrapersonal communication) or for connecting to a higher-level network and the Internet.

Personal Digital Cellular (PDC): behind **GSM** and D-AMPS, the world's mostly widely used digital system. Its use is limited to Japan.

Personal Handyphone System (PHS): a newer Japanese standard especially designed for high-speed data transmission up to 32 Kbps. Some installations may also be found in parts of China, Thailand, and Taiwan.

Radio Frequency Identification (**RFID**): a method of remotely storing and retrieving data. An RFID tag is a small object, such as an adhesive sticker that can be attached to or incorporated into a product. RFID tags contain antennas to enable them to receive and respond to radio-frequency queries from an RFID transceiver.

Short Message Service (**SMS**): available on most digital mobile phones, a service that permits the sending of short messages (also known as SMSes, text messages, messages, or simply texts or even txts) between mobile phones and other handheld devices. SMS was originally designed as part of the **GSM** digital mobile phone standard but is now available on a wide range of networks, including **3G** networks.

Smartphone: any handheld device that integrates personal information management and mobile phone capabilities in the same device. Often, this includes adding phone functions to already capable PDAs or putting "smart" capabilities, such as PDA functions, into a mobile phone. The key feature of a smartphone is that one can install additional applications to the device. Features tend to include Internet access, e-mail access, scheduling software, built-in camera, contact management, and occasionally the ability to read files in a variety of formats including Macromedia Flash and Microsoft Office applications.

Symbian: an operating system for smart phones. In an August 2004 report by In-Stat/MDR, Symbian-based smartphones were predicted to dominate over the next five years. Microsoft's CE platform is predicted to be second by 2006.

Time Division Multiple Access (TDMA): t he first digital network widely used in the Americas, this system is the core of major U.S. wireless networks. The increasing growth of **GSM** and **CDMA** in the Americas is predicted to bring an end to TDMA.

Universal Mobile Telecommunications System (UMTS): one of the third-generation **(3G)** mobile phone technologies. It uses **W-CDMA** as the underlying standard. UMTS is sometimes marketed as 3GSM, emphasizing the combination of the 3G nature of the technology and the **GSM** standard, which it was designed to succeed.

Wideband Code Division Multiple Access (W-CDMA): a wideband spread-spectrum **3G** mobile telecommunications air interface allied with the **GSM** standard. W-CDMA is the technology behind **UMTS.** Networks using W-CDMA are a form of cellular network.

WiFi: *See* 802.11.

Worldwide Interoperability for Microwave Access (WiMAX)the domain of working group number 16 of the IEEE 802 (IEEE 802.16) that specializes in point-to-multipoint broadband wireless access. Predictions suggest that WiMAX will take over the **3G** networks and become the **4G** wireless technology.

NOTES

[i] Samantha Chapnick and Jimm Meloy, *Renaissance eLearning : Creating Dramatic and Unconventional Learning Experiences*. Pfeiffer (January 20, 2005).

[ii] Rob Reynolds, "Technology Trends for the New Year." *xplanazine*. January 2, 2006. http://www.xplanazine.com/archives/2006/01/technology_tren.php Accessed 8 February 2006.

[iii] Wayne Grant, "Wireless Coyote: a computer-supported field trip." *Communications of the ACM*, Vol. 36, Issue 5 (May 1993), pp. 57-59.

[iv] Jane McGonigal, scholar and puppet master, in various presentations. See http://www.avantgame.com/.

[v] Some of this history is chronicled in Bob Johnstone, *Never Mind the Laptops: Kids, Computers and the Transformation of Learning*. New York, iUniverse: 2003. Papert is also a principle in the MIT effort led by Nicholas Negroponte to produce a laptop computer that can sell for $100, One Laptop per Child (OLPC), http://laptop.org.

[vi] Project Inkwell, an initiative sponsored by the Strategic News Service, states its mission as follows: "Inkwell intends to be the standards body for computing platforms for pre-K through 12 education. Our goal is to greatly increase the size and effectiveness of the pre-K through 12 education technology market by managing the synthesis of functional specifications for a ubiquitous computing platform to be employed when and where students and educators engage in learning, teaching, and professional tasks. This specification is meant to describe minimal functionality while encouraging innovation and differentiation of the Inkwell certified devices. Our initial product is a functional specification for a one-to-one–centered hardware platform with a relevant utility, uniformity, and upgradeability to enable the very best technology-based education for all students." www.projectinkwell.com.

[vii] Beginning in 1999-2000, all middle school students and teachers in Maine were equipped with laptop computers in a project begun by then governor Angus King, who cited Seymour Papert as his inspiration. "Maine Learning Technology Initiative", http://www.state.me.us/mlte/about/index.htm.

[viii] "Cobb County: Laptop grand jury is unusual; Panels rarely are formed to investigate issues in which no illegality is alleged," *ajc.com*. October 9, 2005. www.ajc.com/search/content/auto/epaper/editions/yesterday/northside_3484a784946031c00032.html

[ix] "WP 4 – Guidelines for Learning/Teaching/Tutoring in a Mobile Environment," MOBILearn, p. 5.10 June 2003. [Hereinafter, "Guidelines"] http://www.mobilearn.org/download/results/guidelines.pdf. See Bryan Alexander's thoughts on "learning swarms" in his article, "Going Nomadic: Mobile Learning in Higher Education." EDUCAUSE Review, vol. 39, no. 5 (September/October 2004) 28-35. http://www.educause.edu/pub/er/erm04/erm0451.asp.

[x] See for example, Laura Naismith, Peter Lonsdale, Giasemi Vavoula; and Mike Sharples, *Report 11: Literature Review in Mobile Technologies and Learning.* Nesta Futurelab Series. 2004. http://www.nestafuturelab.org/research/lit_reviews.htm#lr11; "Kenya Pilots Handheld Education," *BBC News.* 29 July 2005. http://news.bbc.co.uk/1/hi/programmes/click_online/4727617.stm; and, Mark Finn and Natalie Vandenham, "The Handheld Classroom: Educational Implications of Mobile Computing." Australian Journal of Emerging Technologies and Society, Vol. 2, No. 1, 2004; http://www.swin.edu.au/sbs/ajets/journal/issue2/abstract_handheld.htm; and, Jill Attewell, "Mobile technologies and learning: A technology update and m-learning project summary." Learning Skills and Development Agency, 2005. www.lsda.org.uk/files/pdf/041923RS.pdf, to name but a few.

[xi] Giogio Da Bromida, Giancarlo Bo, Paul Lefrere, and Josie Taylor, "An Open Abstract Framework for Modeling Interoperability of Mobile Learning Services." MOBIlearn. http://www.mobilearn.org/download/results/OMAF_final_submssion.pdf.

[xii] Guidelines, p. 6.

[xiii] See, for example, Matthew Maier, "2006 Promises Hi-Speed Wireless Boom," which contrasts the battle between WiFi and G3. *Business 2.0*. January 6, 2006. http://money.cnn.com/2005/12/22/technology/ces_biz20_122205/.

[xiv] Guidelines, p. 6.

[xv] "Backpacks, Lunch Boxes and Cells? ... Nearly Half of US Teens and Tweens Have Cell Phones, According to NOP World mKids Study." *GfK NOP*. March 9, 2005. http://www.nopworld.com/news.asp?go=news_item&key=151. See also, Amanda Lenhart, Mary Madden, and Paul Hitlin. *Teens and Technology: Youth are leading the transition to a fully wired and mobile nation.* Pew Internet & American Life Project. July 27, 2005. www.pewinternet.org/PPF/r/162/report_display.asp

[xvi] Mizuko Ito, Daisuke Okabe, and Misa Matsuda, *Personal, Portable, Pedestrian: Mobile Phones in Japanese Life*. Cambridge, MIT Press, 2005.

[xvii] Summarized by Graeme Daniel, "Mobile/Cell Phones in Education." *wwwtools for Education*. January 16, 2006. http://m.fasfind.com/wwwtools/m/2717.cfm?x=0&rid=2717. See Mark Prensky, "What can you learn from a cell phone? Almost anything!" *Innovate* 1 (5). 2005. http://www.innovateonline.info/index.php?view=article&id=83.

[xviii] *Ibid*.

[xix] Todd, James. "The iPod iDea: Wired for Scholarship," *Duke Magazine*. Volume 91, No. 5, September-October 2005. http://www.dukemagazine.duke.edu/dukemag/issues/091005/ipod2.html.

[xx] *The 2006 Horizon Report*. New Media Consortium & EDUCAUSE Learning Initiative. 2006. p. 5. http://www.nmc.net/pdf/2006_Horizon_Report.pdf. "At the leading edge of a wave that will last for the next several years and beyond, personal broadcasting takes advantage of small, easy-to-use devices that people already carry to capture and share personal experiences, information, and events. This trend, which has roots in text-based media (personal websites and blogs), is expanding to include audio and video, as the tools for capturing and sharing those media become smaller and better." p. 11.

[xxi] Ellen D. Wagner, "Enabling Mobile Learning." *EDUCAUSE Review*. Vol. 40, no. 3 (May/June 2005): 40-43. http://www.educause.edu/apps/er/erm05/erm0532.asp.

[xxii] Xeni Jardin, "How Mobile Phones Conquered Japan." *Wired News*. August 19, 2005. http://www.wired.com/news/culture/0,1284,68537,00.html. Ito, et.al., cf. *supra*.

[xxiii] Phil Vahey and Valerie Crawford, *Learning With Handhelds: Findings from Classroom Research*. Menlo Park. CA: SRI International, 2003. http://www.intel.com/education/handhelds/SRI.pdf. p. 3 ff.

[xxiv] Peter Meng, "Podcasting and VODcasting: A White Paper." March 2005. http://edmarketing.apple.com/adcinstitute/wp-content/Missouri_Podcasting_White_Paper.pdf Accessed 2 February 2006. Meng continues, "Both distribution technologies will quickly create demand for more bandwidth and storage for that content, both for academic purposes and student-social activities. They will intensify the need for a centralized content management and monetization infrastructure, as well as an education support architecture to assist faculty in the integration of these technologies that will be demanded by the incoming class of students. But in this challenge is also the opportunity to provide all new classes of services for on-campus, distance and lifelong learners. In fact the greatest opportunities for these technologies are in the ways they will be used that have not been imagined yet. The portable and on-demand nature of podcasting and VODcasting make them technologies worth pursuing, implementing and supporting." P. 10.

[xxv] May Wong, "Apple offers college lectures via podcasts," *Associated Press*, January 28, 2006. See *SiliconValley.com*. http://www.siliconvalley.com/mld/siliconvalley/business/technology/13730777.htm. "iTunes U: Click. Sync. Learn." *Apple Computer*. www.apple.com/education/solutions/itunes_u/

[xxvi] "Presenting Stanford on iTunes." *Stanford University*. http://itunes.stanford.edu/. Interestingly enough, a non-mobile oriented open education resources initiative has chosen to use an iTunes-like interface to allow users to search for and select content; see, *Open Media Network*. www.omn.org.

[xxvii] "3G is an ITU specification for the third generation (analog cellular was the first generation, digital PCS the second) of mobile communications technology. 3G promises increased bandwidth, up to 384 Kbps when a device is stationary or moving at pedestrian speed, 128 Kbps in a car, and 2 Mbps in fixed applications. 3G will work over wireless air interfaces such as GSM, TDMA, and CDMA. The new EDGE air interface has been developed specifically to meet the bandwidth needs of 3G." From *Wi-Fi Planet*. http://wi-fiplanet.webopedia.com/TERM/3/3G.html.

[xxviii] "Reading Books On Cell Phones." Tokyo, March 23, 2005. *CBS News*. www.cbsnews.com/stories/2005/03/23/tech/main682569.shtml.

[xxix] "BuddyBuzz is the fastest way to read text on a mobile phone. With BuddyBuzz you get access to thousands of articles." *BuddyBuzz Reading Community*. Created by the Stanford Persuasive Technology Lab. www.buddybuzz.net/rel/Web/index.html.

[xxx] *Edumetrics Learning*. http://edumetricslearning.com/.