

# Limitations of Mobile Phone Learning

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*In this article, we discuss weaknesses inherent in mobile phone learning, and factors that limit its viability. (We do not discuss other m-learning devices such as PDAs.) We conclude that, while e-learning has met with some acceptance among educators and is increasingly being implemented, it will be necessary to solve the problems that we discuss before m-learning can become effective, accepted and widely used. Educators who are interested in using mobile phones for learning with their students should be aware of the current limitations.*

## M-learning: an Exciting Trend

These numbers are indeed astonishing: There are currently 1.7 billion mobile phones in use around the world, while the total world population is 6 billion (Keegan, 2004). In the last 10 years, the development of mobile phone technology has been unbelievably swift: from analog to digital, and from plain and simple cell phones to the current 3G smart phone which can serve as a mini-computer, telephone, or camera, and transfer data as well as video and audio files. There seems to be a constant stream of new technology breaking into the mobile phone market (Attewell, 2005). In Japan, as of December 2004, the number of cell phone contracts (mainly with AU-KDDI, NTT DoCoMo and Vodafone) already exceeded 85,483,800, equal to roughly two-thirds of Japan's total population. Considering that there might be several cell phones being used by members of the same family on a single contract (Japan Shikoku Area Telecommunication, 2005), this represents a much larger percentage of the population actually using cell phones. If you walk onto any university campus in Japan, you will find a majority of students carrying mobile phones. Many will be silently reading emails or c-mails and inputting information (Houser & Thornton, 2004). Up to the beginning of 2004, in China, 335 million Chinese had mobile phones and this number is increasing by 25% or

more every year. Among the present users, 68% have WAP (Wireless Application Protocol) services (iResearch Co. Ltd., 2005).

The above statistical data indicates that mobile phone learning does have a hardware foundation; and, with the establishment of m-learning pedagogical theory (Ogata & Yano, 2004), there are many countries, especially in Europe, where open universities have already successfully introduced mobile learning into distance education programs, and the results have been very positive.

We therefore accept that mobile learning can, and probably will, play a more important role in life-long learning processes. However, due to technical limitations, as well as human psychology, mobile phone learning is still limited to an assistance-only function. Traditional classroom learning, or even distance learning through interactive educational television classrooms (e-learning) should not be brushed aside, and the real potential of mobile phone learning should not be exaggerated.

### Mobile Phone Learning Limitations: Psychological

M-learning is the acquisition of any knowledge or skill through using mobile technology, anywhere, anytime (Geddes, 2004). With m-devices, currently mainly mobile phones, PDAs, and iPods, proponents say that people can learn on airplanes, trains, buses, and so on, when they are on the move or in parks, at home, at the airport, or in train stations. M-learning happens when people are away from their offices or classrooms. Realistically though, for students or company staff, since any learning needs effort and brainwork, how many of them want to study or learn rather than relax on the bus or in the car on the way home after a long day of work or study? On the way back home from school or office, most people prefer to listen to music, the radio news, or sports programs. When they get home, if they want to learn, mobile devices are not likely to be their main choice. The more likely choices would be DVD/CD Players, videotapes, computers installed with learning software or computers with high speed access to the Internet for e-learning. Mobile phones will mainly be used for communications with other people, not for learning purposes. M-learning does not replace traditional learning, but is just another way of learning using a new technology. The fundamentals of learning still do not change with mobile learning (Razak, 2004). Even in Japan, students, who are the group of people most likely to use mobile phones for learning, seldom use their mobile phones for educational purposes (Thornton & Houser, 2005). In short, many people would lack the motivation needed to use mobile phone learning consistently.

Another consideration is that even after a new learning option is developed, habits take time to change (James, 1890). For example, even though there are many free e-learning foreign language materials on the web, people still buy books and CDs. Also, many university students have electronic dictionaries, but still tend to have a book dictionary. Email and digital signature technology have been available for business purposes for many years, but people still tend to use telephone or fax for confirmations. This is not a problem of network technology and bandwidth, but rather of habit.

Although medical researchers have so far not found any evidence to prove that there is a relationship between mobile phone use and brain or aural impairment (Sievert *et al.*, 2005), many people still suspect that frequently using mobile phones is the reason for the

increased incidence of brain tumors and other brain or aural diseases. It has been shown that mobile phone radiation actually does cause increases in blood pressure (Braune *et al.*, 1998). A survey conducted in Europe indicated that 60% of the participants agreed that the use of mobile phones by children and teenagers should be restricted due to possible health risks (Siegrist *et al.*, 2005). Considerations such as these have kept some people from using mobile phones altogether, or at least limited their use, until more is known about the health effects of using the voice function of a mobile phone. This obviously impacts on the number of people willing to undertake m-learning. Using a mobile phone when held away from the head, to read mails or web pages, may not give rise to health problems; however, this would be to exclude using FM radio, or the foreign language listening programs embedded in more and more models of mobile phone.

### Mobile Phone Learning Limitations: Pedagogical

According to Clark Quinn, director of cognitive systems at *KnowledgePlanet*, the vision of m-learning is clear: it lies at the intersection of mobile computing and e-learning and offers anytime, anywhere resources; strong search capabilities; rich interaction; powerful support for effective learning; and performance-based assessment. From courseware to performance-ware, the stand-alone learning content model needs to transform into a context-driven, task-sensitive, performance support model (Singh, 2003). However, precisely because m-learning (in our case, mobile phone learning) can theoretically take place anywhere and anytime, it is hard to follow up on the learning achievements of those attempting it. Individuals take full responsibility for their own learning. Most organizations like to keep track of who is doing what to whom and when, using some form of learning management system (LMS). This serves to update corporate skill bases and inform those responsible for supporting m-learners, such as online tutors. The lack of "always on" connectivity makes tracking data a difficult task on mobile devices (Shepherds, 2001). Other people have argued that tracking user activity on mobile phone devices is extremely easy. Naturally, one does not always get immediate feedback from the mobile phone, but one simply catches the data on the device and uploads it when connectivity is next available. However, if this is not a significant hurdle, then what is the meaning of learning interaction? In most cases, both common sense and good pedagogical practice have taught us that learning and teaching need quick interactions in order to be most effective.

Also, in m-learning courses, whether based on mobile phones or other mobile devices, it is hard to administer a test. Without on-site supervision, course organizers have no reason to trust that the answers sent from a mobile phone are being sent personally by the actual registered mobile phone holder and m-learner. This is also a consideration in other forms of e-learning; while not unique to m-learning, it is still considered to be a major weakness in the pedagogical system.

Studies and statistics show that between 20%-30% of those students who begin distance learning (e-learning & m-learning) courses do not finish (Rovai, 2002). In an m-learning environment, the lack of a firm framework tends to encourage laziness; therefore a strict self-discipline, which many adolescents lack, is required. Also, in mobile-learning there is an absence of a "learning atmosphere". According to the survey conducted by Marcus in 2003 (cited in Bouhnik & Marcus, 2006), many students reported that distance learning (which, of

course, would include mobile phone learning) was less efficient, when compared to a “face-to-face” learning format, and required them to devote more time to learning the subject. Students who are used to traditional teaching/learning methods feel that mobile phone learning lacks interpersonal and direct interaction (Bouhnik & Marcus, 2006), unless they call or send mails to their teachers, and that costs both money and more time.

Finally, as mobile phone learning is a method for learning on the move, it is unavoidable that the surrounding environment will often interrupt the learning process. Learners cannot focus all of their attention on learning while on the move. If the interruptions and distractions occur frequently enough, educators believe the learners will gradually become resistant to mobile learning in the same way as has been found in other transitory learning environments.

## Mobile Phone Learning Limitations: Technical

### *1. Small screens and low resolutions*

In order to view images and text, a large mobile phone screen is, of course, preferable. It is true that mobile phone makers have made their screens larger and larger. However, it obviously cannot be too large or mobile phones would not be portable or convenient. According to the authors’ observations, as of September, 2005 most mobile phone screens are between 1.5-2.6 inches in size. This size might be all right for viewing texts for a short time, but usually not for longer than one or two minutes, as for longer than that people’s eyes become tired (Bryan, 2004). Unfortunately, to read and respond to m-learning texts usually needs more than two minutes. People tend to prefer printing out electronic documents to read instead of reading them on computer screens, because printed books and documents usually have resolutions of at least 200 dpi. It is generally not possible or feasible to print directly from a mobile phone.

Resolution is another problem. Most mobile phones’ image resolution cannot compete with computers whose resolutions are usually 800 × 600 or 1024 × 768 pixels. The highest image resolution so far on mobile phones is just Q-VGA 240 × 320 pixels (Mitsubishi and Samsung). Even on computers with high resolution, people’s eyes become tired after relatively short periods of time. On even the largest mobile phone screen, with such a low image resolution, it is obvious that it would be harmful to the human eye to spend much time reading or inputting data.

Also, as mentioned above, unlike computers, most mobile phones cannot be connected directly to a printer; a special mobile phone SM card is necessary, to output data to a computer for printing. Hence, people have to struggle with the small fonts on the small screen. This limitation will keep a lot of middle-aged or elderly learners from taking mobile learning courses.

### *2. Input limitations*

Current mobile input is not at all user-friendly. Slow and inconvenient input methods are real problems with mobile phones. To input a word in any language, users may have to hit a key several times even to find the right letter, and it takes time to switch between the

number input mode and letter mode. In the case of inputting in the Japanese language, users have to struggle with seven input modes: English, numbers, kanji, katakana, hiragana, and punctuation in single- and double-byte. The authors interviewed the staff at three mobile phone retail stores (au KDDI, Vodafone, and NTT DoCoMo); the staff reported that 90% of their customers who require email services on their mobile phones are young people, and among these young people, 70% are girls. Apparently, these girls like, or at least do not mind, writing emails or replying to emails with their mobile phones. This may be partly due to girls being more nimble-fingered than boys. Indeed, the authors found, among their students, that most girls can key in data very quickly. However, the real word input speed is still less than 1/10 the input speed when they use a computer keyboard, according to our own experiment - as is corroborated by another experiment (Houser & Thornton, 2004).

Some companies have started to employ various wireless mobile technologies such as Bluetooth and infrared ports to enable data exchange between computers and mobile phones (Chugoku Branch, KDDI Company, 2005). However, this does not really solve the input problem of mobile phones. These companies are simply taking advantage of faster computer keyboard input for mobile phones. Without a computer and its keyboard available, the problem remains, regardless of the wireless technology available.

Some mobile phones provide for voice dialing or email reading; however, the service of text input via voice still cannot be fully provided because the technology of speech to text is not mature. Therefore, users have to input words by hand, which is slow and associated with extra spelling errors. So far, very few mobile phones have spell-check functions.

Of course, students could turn to the use of portable folding computer keyboards that can be connected to a mobile phone for input, but this would force them to sit down or stand still to focus on inputting. At this point, mobile-learning will have lost some of its mobility. Several newly-marketed smart phones have a very small but otherwise typical QWERTY keyboard layout, and can exchange office files with Windows OS. Still, because of the problems of small screen size and inconvenient text input (even if there is a QWERTY keyboard, it is still extremely small and difficult to use as quickly as a full-size keyboard), editing office files on a smart phone or mobile phone is hard. Until speech recognition technology becomes mature enough that mobile phones do not need hand inputting, the mobile phone's role in distance m-learning will be very limited.

### ***3. The limitations of accessing the Internet***

As the mobile phone wireless network is different from cabled Internet networks, it is difficult to access ordinary Internet web pages from a mobile phone. Most ordinary Internet web pages are distorted on mobile phone screens and a lot of multi-media information is lost. Therefore, in order to enable mobile phone access to the Internet, it is necessary to design special web pages, currently mainly using WML language, and simplify the web function. However, the download speed is still low. The authors experimented with ten different models of mobile phone, owned by our students, and found that, on average, it took 6 seconds for every link access to a new page to completely appear, while on standard computers using mid-range broadband, access to the same text page took just 2 seconds. Even on mobile phones on 3G networks (W-CDMA or cdma2000) so far it is hard to reach the download speed of 384kbps, although the connection is robust.

Also, there is the problem of browsing study materials on mobile phones. Currently, very few mobile phone browsers can view content satisfactorily in more than two languages, which are usually English and the user's mother language. The same limitation applies to mobile phone emails. Given these limitations, how can foreign language learning be efficiently done on mobile phones? Does an Australian student majoring in Japanese language have to buy a mobile phone made in Japan, in order to take part in an m-learning course? Would the phone work in Australia?

The Opera Software ASA Company has developed a special browser, Opera, for users to view any web site from their mobile phones; it is now embedded in many models of mobile phone, including models made by Sony Ericsson, Nokia and Siemens. The Opera Mobile Accelerator reduces the size of web pages by approximately 50-70%



Figure 1. Opera mobile phone browser

This is actually a good browser but, due to the small size of the mobile phone screen, users have to frequently press the right and left keys in order to view the other part of the page, which was originally designed for computer screens. Nor is the speed fast. Low Internet speeds (even on 3G mobile phones) act as a major limiting constraint on effective mobile phone learning processes.

WAP, short for Wireless Application Protocol, is a specification that allows users to access information instantly via mobile phones. The WML of WAP is specifically devised for small screens and one-hand navigation without a keyboard. It has almost been adopted as a formal standard in Europe and the US; and efforts are being made to have the protocol adopted in Japan. It is an initiative that was started by Unwired Planet, Motorola, Nokia, and Ericsson. The trouble with Internet standards such as HTML, HTTP, TLS, and TCP is that they require large amounts of mainly text-based data to be sent, which is a big problem in bandwidth constrained systems like mobile wireless systems. As an example, HTTP sends its headers and commands in an inefficient text format instead of compressed binary. Another example is the TLS security standard that requires many messages to be exchanged between client and server. HTTP and TCP are not optimized for the usual problems associated with wireless networks like mobile phone networks; or for limited bandwidth which, with wireless transmission latencies, results in a very slow response for the user.

The cost of using WAP is another disadvantage. In Japan, for example, an email package costs \$3~\$5 a month, but accessing the Internet (through WAP) will usually cost about 5 cents per screen (AU-KDDI & Vodafone websites, 2005). The price must also be a factor affecting mobile-learning, since many m-learning materials have to be viewed online or downloaded.

#### 4. Lack of standardization and compatibility

In practice, m-learning materials designers find it is currently impossible to design a generic version for all platforms (Attewell, 2005). Teachers have to design different learning materials specifically for particular mobile platforms. Although in Europe and the US most phones come standard with WAP, NTT DoCoMo in Japan uses i-mode. Further, different telecommunications companies use different wireless networks. For instance, since 1992, GSM has witnessed a very rapid development in Europe; in North America and Japan, TDMA and CDMA networks were developed independently; and, in Japan and Korea, GSM has never been used. In the 3G development craze in 2004 and 2005, Japan mainly deployed W-CDMA, while the US and Europe use cdma2000, and China is testing the Chinese standard of TD-SCDMA and developing WAPI (Wired Authentication and Privacy Infrastructure, a Chinese National Standard for Wireless LAN; although it is supposed to work on top of WiFi, compatibility with the security protocol used by the 802.11 wireless networking standard developed by the Institute of Electrical and Electronics Engineers Inc. (IEEE) is in dispute), motivated by considerations of national information security. Coexistent with the

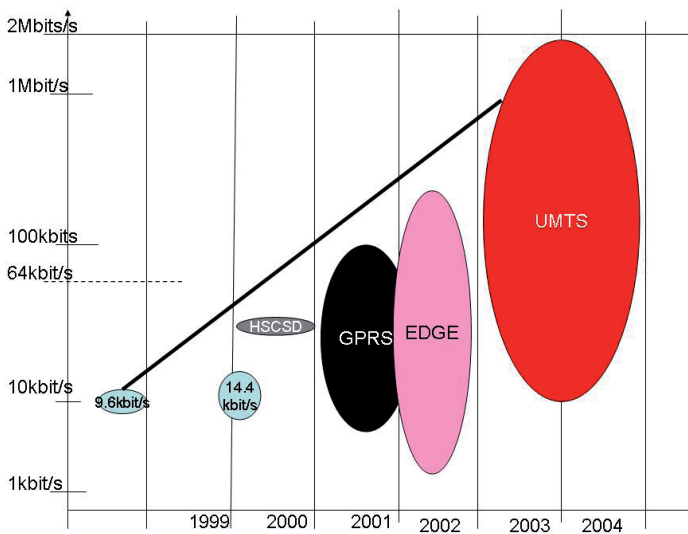


Figure 2. In spite of current different technical standards, UMTS is the ultimate standard for 3G mobile phones

above two 3G networks, 2G networks (GMS) and 2.5G (GPRS) networks are still being used; in the US, some areas are still using 1G network mobile phones. The biggest difficulty in 3G development is how to reach a standard or agreement among those telecommunications companies that have already invested huge funds in existing CDMA/TDMA/FDMA networks (Bates & Gregory, 2001). In the current 3G craze, a telecommunications company will still be trying to decide among the following 5 choices: UMTS, cdma2000, WCDMA, TD/CDMA and UWC-136. When global roaming phones move from one network to another, disconnections often happen.

In terms of using Wi-Fi for cell-phones to access the Internet and Bluetooth technologies for connecting different mobile or non-mobile devices for data transmission, both wireless technologies have drawbacks. For example, when a user connects his mobile phone to his printer and laptop, all three machines have to be equipped with Bluetooth technology and, even then, with rare exceptions, it is difficult to get the three machines to communicate with each other. Wi-Fi also has many disadvantages. For example, Wi-Fi equipment uses a lot of power; and relevant regulations are not consistent worldwide: most of Europe allows for an additional 2 channels beyond North America, while Japan has one more on top of that.

### **5. Additional limitations**

There are also other limitations that should be considered, including a universally small memory and storage capacity in mobile phones, which limits the length of emails, the opening of attachments, and the use of tabs or multiple windows. The largest memory we have found so far on the market is 40 MB (although industry analysis indicates that mobile phones with larger memory will be coming soon), in e.g. the SANYO W22SA and Toshiba A5511T. And the external memory which mobile phones support is usually from 32-512MB with very few exceptions of more than 1GB (W315 Sony Ericsson supports 2GB external SM). Learners are thus unable to store any large video, audio or high-resolution files. As alluded to above, many mobile phones even limit the length of emails that can be received. The same is true for c-mails (SMS). In Japan, currently most c-mails are limited to 50 Chinese characters, which means teachers and students engaged in m-learning often have to send several separate c-mails. At present, m-learning relies on email or SMS as the main methods of interaction between learners and instructors. If the email /SMS function is limited, then one has to doubt the efficacy of m-learning conducted on mobile phones.

Almost all of the mobile phone companies provide c-mail (SMS, EMS or MMS) service. However, different telecommunications companies' c-mail services are often not compatible with each other. For example, in Japan, AU-KDDI mobile phones cannot send c-mails to NTT DoCoMo, or vice versa. Suppose a teacher needs to send messages to students who have contracts with different telecommunication companies. What will the teacher do? Will it be necessary for the teacher to have two or three mobile phones? Obviously, that would be impractical.

M-learning is characterized by its ubiquity. However, in some countries, like China and Korea, because receiving phone calls also costs money, users often turn off their mobile phones when they are not immediately engaged in any necessary business. M-learning LMS would be difficult in this kind of situation. In Japan and England, on public transportation, in hospitals and other public facilities, mobile phones are discouraged, if not prohibited.

Nor can we ignore network facility limitations. In spite of the claims of ubiquity made for m-learning, in some locations and areas, such as in tunnels, elevators, lower floors in a densely built-up area, in mountainous regions, on ships at sea, or in sparsely populated countryside, people cannot receive any mobile information. An experiment: One of the authors took the Shinkansen (Japanese Bullet Train) from Shinyamaguchi to Nagoya, a distance of 661 km that took 2 hours 45 minutes. He found that for at least half of the trip, his mobile phone either had no signal or could receive only a very weak signal. Hence, on fast-moving transportation, m-learning is impractical or, in the case of aircraft, even dangerous. Add to this various country limitations. Different countries have different technical standards for mobile phones so, when users travel to other countries, it may be difficult for them to continue with m-learning. Even if they have a mobile phone which has tri-band GSM capability, which should enable worldwide usage, some m-learning functions will be lost or disabled.

It could be argued that, even if a mobile phone cannot connect, a learner can still do stand-alone learning using the unconnected mobile phone. However, the user will still have to face the same technical limitations discussed in previous subsections: a small screen, inconvenient input, limited memory, et cetera.

Mobile phone movie email, 3-D games, TV calls, high-resolution-camera and TV show functions (very high and quick battery usage requirements) have just become available on the market. Still, in what way these functions can be effectively used for m-learning is a total unknown. Educators need time to research and test accessibility and efficacy.

### Feedback from Japanese University Student Mobile Users

We conducted a limited sample survey of mobile use among 32 university students. Respondents were mainly 3<sup>rd</sup> and 4<sup>th</sup> year students, plus graduate students (n=32: 18 females, 14 males, with an average age of 21.3 years) here in our university. To our surprise, we found that 22 students had not yet figured out all of the functions of their mobile phones; 10 had rejected email services when signing the contract with their telecommunications company; and 9 had bought their mobile phone more than two years previously, and so had no Internet access function. 23 students, whose mobile phones could connect to the Internet, often downloaded music, for use as ring tones, and sometimes downloaded games. 23 students often checked emails related to their classes in the computer lab, using a PC; mobile phone email was used only socially. Five students had even stopped using email altogether, because they had received too much spam. Only seven of the 32 had used the dictionary function on their mobile phones, and they said they did not like the mobile phone dictionary – the “explanation for each word is too simple.”

Our survey results are different from a similar survey, also conducted in Japan (Thornton & Houser, 2005). They claimed that in their survey, 99% of the participants reported sending email on their mobile phones, and only 43% indicated that they send emails from their PCs. This discrepancy might be due to the fact that their subjects (aged from 18-21) were all females and most of them were not in the higher grades of the university or graduate school, so that they did not have a fixed lab with a fixed desk equipped with a PC constantly connected to the Internet by broadband, so that they had no choice but to use their mobile phones to check emails.

From our simple survey, we found that the mobile phone is still a device mainly used for voice communication, and personal information exchange. Students have not realized that their mobile phone could also be a device for ubiquitous learning. This survey also reflects that m-learning using mobile phones will still take some time to be accepted as a part of the average person's life-long studies.

In our survey, we also heard this expressed: "E-mail is a kind of personal information, and teachers do not have the right to force the students to tell their personal email address." Indeed, the Japanese government has passed an "Act on the Protection of Personal Information" (available from <http://www5.cao.go.jp/seikatsu/kojin/foreign/act.pdf>), which went into force from April 1, 2005. How then are those teachers who are interested in mobile phone learning to deal with students who are reluctant to give their mobile phone email address or even mobile phone number?

## Conclusion

In this paper, from the psychological, pedagogical and technical standpoints, we have analyzed the limitations of mobile phone learning. Psychologically, people have not become used to mobile phone learning; pedagogically, mobile learning results are not easy to evaluate or follow-up; and, technically, small screen size, inconvenient input, small memory, and the lack of common standards are hindrances that keep people away from learning using mobile phones.

Due, in part, to so many limitations of mobile phone learning, we have found that, so far, m-learning materials are mostly studies of foreign language words, phrases, quizzes, homework assignments, news announcements, and simple games for those mobile phones that support game functions.

Unless mobile phone makers or telecommunications companies can overcome the psychological and technical limitations discussed in this paper, m-learning, at least m-learning conducted on mobile phones, will not play an important, much less an indispensable, role in distance education.

Though it can be argued that m-learning does not mean only mobile phones, the question then becomes what proportion of learners (who tend, at this time, to be mainly students with limited income) can afford to buy or have a small, expensive PC equipped with a wireless LAN card, a PDA, or an iPod?

The limitations discussed here must be seriously considered, as these are the main limitations that inhibit acceptance and widespread use of m-learning, rather than any problems with educational methodology, pedagogy, or materials creation.

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