Using mobile phones in English education in Japan

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Abstract

We present three studies in mobile learning.

First, we polled 333 Japanese university students regarding their use of mobile devices. One hundred percent reported owning a mobile phone. Ninety-nine percent send e-mail on their mobile phones, exchanging some 200 e-mail messages each week. Sixty-six percent e-mail peers about classes; 44% e-mail for studying. In contrast, only 43% e-mail on PCs, exchanging an average of only two messages per week. Only 20% had used a personal digital assistant.

Second, we e-mailed 100-word English vocabulary lessons at timed intervals to the mobile phones of 44 Japanese university students, hoping to promote regular study. Compared with students urged to regularly study identical materials on paper or Web, students receiving mobile e-mail learned more ($P < 0.05$). Seventy-one percent of the subjects preferred receiving these lessons on mobile phones rather than PCs. Ninety-three percent felt this a valuable teaching method.

Third, we created a Web site explaining English idioms. Student-produced animation shows each idiom's literal meaning; a video shows the idiomatic meaning. Textual materials include an explanation, script, and quiz. Thirty-one Japanese college sophomores evaluated the site using video-capable mobile phones, finding few technical difficulties, and rating highly its educational effectiveness.

Keywords

e-mail, foreign language learning, individual, mobile phones, multimedia, quantitative, undergraduate, video, World Wide Web

Introduction

If you walk onto any university campus in Japan, you will find a majority of students carrying mobile phones. Many will be silently tapping away, composing or reading e-mail, as they walk between classes. Others will be having quick conversations, letting other students know about missed classes or evening plans. According to Taylor (2001), 95% of the 15–24 years old population in Japan own Web-enabled mobile phones. In Japanese society as a whole, mobile phones outnumber PCs five to one (Cohen 2002). Japanese young people have been quick to adopt a mobile technology that allows them to e-mail their friends and access the Web as they move through their daily schedule. Given their popularity, we wanted to know to what extent mobile phones were being utilized for educational purposes among university students, and to measure students' reactions to educational materials for foreign language learning developed specifically for mobile phones.

Learning a foreign language involves memorization and practice of a large number of vocabulary words and grammatical structures. For students of English as a Foreign Language (EFL), 5000 base words are

considered a minimal requirement for understanding non-specialized English texts (Laufer 1997; Nation 1990). Recent research concerning the brain and learning indicates that retention of a new word or concept depends on the quality and frequency of the information processing activities (Hulstijn 2001). For the learner, this means that words need to be encountered and noticed in speaking, reading, writing, and listening tasks, and then deliberately practiced or rehearsed to facilitate the formation of a lasting memory trace (Hulstijn 2001). Over time, with enough exposure, activation and recognition become relatively automatic (Genesee 2000) which is one of the goals of foreign language learners. Yet, in many educational institutions around the world, the amount of class time is very limited. In Japanese universities, for example, a typical class meets once a week for 90 min. Teachers must make difficult choices about how to use that limited time to promote language learning. Since foreign language students usually have opportunities to speak and hear the target language only in the classroom, it makes sense to use as much class time as possible in communicative activities. This means that other kinds of practice and exposure must be provided in other ways. We believe that mobile technology can help extend learner opportunities in meaningful ways.

With that in mind, we surveyed students at the university to determine patterns of usage of mobile devices, the mobile phone functions they use, and the types of educational activities they consider useful for mobile phones. In this paper, we first present the results of that poll. Then we introduce two types of materials developed for studying EFL on mobile devices for learners in Japan, and present students' reactions to these types of learning activities on mobile phones. The first, *Learning on the Move* (LOTM), sent English vocabulary materials to students at timed intervals, in order to promote regular interval study (Thornton & Houser 2001; Houser *et al.* 2001). LOTM uses the inexpensive mobile e-mail capabilities of common 'second generation' (2G) mobile phones. The second, *Vidioms,* uses the multimedia capabilities of 'third generation' (3G) mobile phones and personal digital assistant (PDAs) (pocket computers) to display short, Web-based videos and 3D animations and to give visual explanations of English idioms (Thornton *et al.* 2003).

Mobile Technology in Japan

Mobile technology and e-mail

We chose mobile phones as the medium for delivery because of their popularity in Japan. At the time our research into mobile learning began in 2000, nearly 60 million Japanese (half the population) constantly carried mobile phones (Mobile Media 2001). In contrast, only 20% had occasional access to desktop PCs. Regarding university students, in April 2000 in an undergraduate course on computers and language learning, we surveyed 48 students to determine how many had computers at home. Eight of the 48 (17%) indicated home access to a computer. Of those same 48 students, 100% had mobile phones.

Japanese mobile phones provide limited but completely standard Internet e-mail. Subscribers have standard e-mail addresses assigned to their phones, and can exchange e-mail with other phones and desktop computers. Modern phones have capable e-mail clients offering photo attachments, multiple mailboxes, 'filters' to automatically categorize incoming mail, and downloads from multiple servers. This is in contrast to European and American mobile phones, which initially provided only limited, proprietary systems for exchanging very short 'text messages' and 'Short Message Service' (SMS) with 'gateways' to and from standard Internet e-mail.

The cost of mobile phone e-mail in Japan is very low. Prices vary between service providers and plans, but most students would be charged about US$0.002 to receive each message; a 2-week set of 30 messages would cost approximately US$0.06. Since students already send and receive so much e-mail on their mobile phones, the cost of our messages would be but a tiny fraction of their mobile e-mail costs. Students with 'flat rate' e-mail service contracts receive our messages at no additional cost.

Mobile technology and the Web

Japanese university students have constant access to the Web through their mobile phones. Table 1 shows that most young adults in Japan own a constantly available Web-enabled phone. However, only a little more than half that number have occasional access to the Web via a desktop PC at home. So, in order to make language-learning materials that were accessible

Table 1. Penetration of Web devices in Japan (percent of population owning device)

Penetration (%)	Device
2	PDA (pocket computer) (JETRO 2002)
58	PC in the household (Japan Ministry of Public Management 2002)
95	Web-enabled mobile phone (subscribers aged 15–24) (Taylor 2001)

to a majority of students, we chose to make pages that could be read on mobile phones. Because of restrictions of mobile phone technology, this required short texts and 15 s videos and animations. Currently the cost of accessing video via mobile phones is prohibitive for students – US$8/min. Although none of our students own PDAs, we wanted to compare students' reactions to our materials on different mobile devices.

A survey of Japanese students' use of mobile devices

We polled 333 female Japanese university students regarding their use of mobile devices. Students' ages ranged from 18 to 21, and fields of study included EFL, modern culture, computers, design, and home economics. The questionnaire was divided into seven sections: personal data (name, class, etc.); types of mobile phone owned; frequency of use of various mobile phone features; use of other electronic devices; the frequency of various categories of e-mail sent or received via mobile phone; categories of Web pages accessed via mobile phone; and a ranking of the desirability of possible educational activities via mobile phone.

First, we found that every student who participated in our poll owned a mobile phone. Most Japanese mobile phones have many features besides making voice calls, but we found that the types and models of our students' mobile phones varied, with some having more multimedia capabilities than others. For example, most phones can run small Java programs, some phones can display Flash animations or electronic books, some include digital voice recorders and small video cameras, and a few can display and record TV broadcasts. However, all modern Japanese mobile phones can view standard Web pages, and send and receive standard Internet e-mail. Of course all these media are limited to some degree by the small size of the phones, but these limitations are gradually disappearing with advances in mobile phone screens, processors, bandwidth, and memory. For example, some older phone models limit outgoing e-mail messages to 500 characters, but most new phones allow receiving messages of 10 000 characters or more.

Our poll showed that e-mail was the most utilized mobile phone feature. Students reported making relatively few voice calls (a mean of seven calls per week). In contrast, students reported exchanging an average of almost 200 e-mail messages on their mobile phones each week. These mobile messages had an average length of about 200 Japanese characters each, roughly equivalent to a paragraph of 70 words, so their length is intermediate between desktop PC e-mail and the short 'SMS' or 'text messages' exchanged between European and American mobile phones.

Next, we compared mobile phone e-mail with PC e-mail. Where 99% of our subjects reported sending e-mail on their mobile phones, only 43% send e-mail from PCs. Subjects reported exchanging an average of only two e-mail messages on PCs per week. We see that mobile e-mail is used much more frequently than both PC e-mail and mobile voice calls.

Regarding other features, many students made occasional use of the appointment calendars and digital cameras built into their mobile phones. Newer features, such as bilingual dictionaries, games, video cameras, and lists of things to do (shopping lists and task lists), were seldom used. (Our instrument failed to distinguish between phones not offering the feature, students not using the feature, and students being unaware they had the feature.)

Table 2 summarizes our poll results on the frequency of usage of various mobile phone features. Subjects also reported using another type of mobile device: the electronic bilingual dictionary (with half-size QWERTY keyboards). All students at our university are required to take 2 years of EFL classes, and many students use these small devices. In our poll we found that more than half the subjects report using them, either occasionally or often. On the other hand, only about 20% of students reported ever using a PDA. (See Table 3.)

Since students were using mobile e-mail extensively, we wanted to find out if they were already

Table 2. Frequency of use of mobile phone features, as reported by 333 Japanese college students

Feature use	M	SD
Send e-mail	194.0	619.0
Receive e-mail	82.8	91.0
Voice call	6.6	7.0
Web	3.9	7.3
Photo	2.8	7.6
Calendar	2.6	4.4
Game	1.6	7.0
Dictionary	0.9	2.4
'to do' lists	0.4	2.1
Record video	0.3	1.0

M denotes the mean response (number of times that feature was used per week) and SD the standard deviation.

Table 3. Frequency of student use of e-mail on PCs, and of other mobile devices (electronic dictionaries, and PDAs) (number of times used each week; $N = 333$)

Device	M	SD
Dictionary	7.5	14.8
PC e-mail	2.2	4.9
PDA	0.8	3.1

Table 4. Purpose of mobile e-mail and Web

Feature use	Mobile e-mail		Mobile Web	
	M	SD	M	SD
Chat	113.0	80.8	4.1	13.7
Class	6.9	19.8	1.0	3.3
Study	3.2	6.1	0.8	2.0
Work	1.5	4.2	0.2	1.0
Magazine	1.5	4.6	0.5	1.6
Event	0.9	11.1	0.3	1.5
Instructor	0.8	6.3	0.3	2.8

Mean and standard deviation of the number of messages sent or Web pages accessed, per week. $N = 333$.

Table 5. Students ranking of the desirability of various functions for mobile phones in an educational setting (1 = most important, 6 = least important; $N = 333$)

Educational function for mobile devices	M	SD
Receiving notifications (class cancellations, room changes, and other administrative details)	1.7	1.0
Receiving and submitting assignments	2.2	0.9
Receiving notification of quiz and test grades	3.5	1.4
Taking lecture notes	3.5	1.5
Answering questions in class	4.1	1.0
Consulting with other students	5.5	1.0

using their mobile phones for educational purposes. A majority (83%) reported using mobile e-mail often for chatting with friends and family. Sixty-six percent reported using it (occasionally or often) to ask other students about classes or lectures. A smaller number, 44%, used mobile mail (occasionally or often) for studying. Most students seldom or never used mobile e-mail for other educational purposes, such as contacting a teacher or finding out about events at the university. Only a few students occasionally or often used their phone for finding out about part-time jobs or reading e-mail magazines. (See Table 4.)

Although 61% of subjects reported using the Web function of their mobile phones at least occasionally, a majority of students reported never using their mobile Web for the purposes we asked about. Twenty-seven percent reported using the mobile Web for chatting with friends. Twenty-two percent used it for studying. Eighteen percent used it for finding out about classes and lectures. Twelve percent read Web-based magazines. Only a very few used it for contacting teachers or finding out about campus events and part-time jobs. (See Table 4.)

Subjects were then asked to rate the desirability of several types of educational functions they would like to have with mobile phones, using a scale of 1–6, with 1 being the most important and 6 being the least important. Table 5 summarizes students' rankings. (E.g., 'Receiving notifications' was the most desired function, ranked first by 62% of the students. 'Receiving and submitting assignments' was the second most desired function, ranked second by 53% of the students.)

Administrative tasks such as receiving notification of cancellations, receiving and submitting assignments, and notification of grades were ranked highest. These were followed by in-class tasks such as taking notes and answering questions. Subjects rated consulting with other students as the least important educational use for mobile technology.

Discussion

The results of our poll indicate that a majority of Japanese students own and frequently use mobile

phones. Students are very practiced at using the e-mail functions of their phones but are less experienced at using the Web and other newer features such as cameras and 'To do' lists. In terms of educational use, more than half of students are already using their mobile e-mail to get information about classes and lectures. They would like to receive administrative information about classes on their mobile phones. Students' lack of interest in exchanging information with their peers via mobile devices may show a preference for face-to-face interaction when studying, or it may reflect Japanese students' confucianistic, instructivistic attitude towards education.

Concerning the mobile Web, to a large degree, students are not yet using mobile Web for educational purposes. We believe that this may be related to the small number of university teachers in Japan that offer information via the Web or online segments of their courses. Ring (2001) posits that Web-based course materials should be decomposed into small pages that can be easily read on small mobile screens, and in his experiments students applauded a hierarchical structure of such small pages. So, even for courses that offer Web-based materials, redesigning is necessary if they are to be accessed by mobile devices.

In order to find out how students felt about materials designed specifically for mobile phones, we developed sets of English vocabulary lessons that utilized the e-mail function of mobile phones, and another set of multimedia lessons teaching English idioms that could be accessed via the Web function of mobile phones. The next two sections introduce these materials and present students' evaluations.

Text materials via mobile phone e-mail: Learning on the move

Research on memory and learning suggests that for an item to be stored in long-term memory, distributed practice is superior to massed practice (Bjork 1979; Wozniak 1995; Dempster 1996). Cognitive psychologists have found that when two presentations of a stimulus are close together (i.e., massed presentation), then the improvement in memory performance, compared with a single presentation, is limited. On the other hand, when two presentations of a stimulus are temporally farther apart (i.e., spaced presentation), then performance on a memory test is significantly better than performance after a single presentation. The advantage in memory performance that occurs when two presentations are spaced instead of massed is referred to as the spacing effect. (Greene (1989) reviews studies investigating the spacing effect.) Studies have examined spacing effects in the learning of foreign language vocabulary without technology (Bahrick & Phelps 1987; Dempster 1987). These show that the number of recalled words was greater under spaced conditions. Other studies have also shown that the type of rehearsal is important: Elaborative rehearsal that causes deeper mental processing is more effective (Craik & Lockhart 1972). This suggests that students of a foreign language should review words at spaced intervals, and in a variety of contexts, to facilitate long-term memory storage.

Research has shown that both intentional learning through explicit instruction (Nation 1990; Coady 1997) and incidental learning through reading (Nagy *et al*. 1987) can lead to vocabulary acquisition in non-native language learners. A combination of these methods is recommended by most experts (Hulstijn 2001; Wood 2001), but existing teaching materials provide inadequate exposure for learning many of the 5000 essential words (Groot 2000). Thus, students need a structured program in which unknown words are identified and then taught in a way that supports long-term memory storage. We thought that a *push* media like e-mail or SMS would provide such a program.

Experiment

Three times a day, at 9:00, 12:30, and 17:00 hours, we e-mailed short mini-lessons (less than 100 words of text or 365 bytes each) to 44 female Japanese university students in two EFL classes. Lessons were discrete chunks readable on the tiny screens of mobile phones. Lessons defined five words per week, used each word in multiple contexts, reviewed previously introduced vocabulary, and incorporated target words in story episodes. (See Table 6.) Pre- and post-tests determined the number of words learned during each 2-week cycle.

Students evaluated this push learning by responding to a questionnaire. Seventy-one percent preferred receiving these lessons on mobile phones rather than PCs. Ninety-three percent responded positively when

Table 6. Example vocabulary-teaching messages sent to students' mobile phones in the Learning on the Move project

Message type and purpose	Sent	Example message
Introducing a target vocabulary word (Target words are always highlighted in capital letters and are glossed with a Japanese equivalent upon first appearance.)	Day 1 9:00	Hello everyone. I hope you are enjoying your new classes. One of today's words is MAINSTREAM (). Do you think you are part of the MAINSTREAM of Japanese culture? If you are part of the MAINSTREAM, it means that your attitudes and actions are very similar to most other Japanese people. Teenagers in Japan who dye their hair purple are not in the MAINSTREAM of Japanese society.
Rehearsal and *new contexts* for target words (This message reviews 3 words that were previously introduced and defined.)	Day 2 12:00	Good afternoon. Are you having a nice day? Many people want to be in the MAINSTREAM of a society. It is more comfortable. When people make positive GENERALIZATIONS such as 'Japanese are very polite', it feels good. But it can be uncomfortable for people who want to be INDIVIDUALS. They are often described with negative GENERALIZATIONS such as 'All girls who play drums are wild.'
Rehearsal in a *serialized story*	Day 1 17:00	Once there was a girl named Susan who lived in Texas. Her parents were from Mexico but Susan was born in the United States. Her parents were very strict and wanted her to become a proper Hispanic young lady. But Susan had other ideas. She was always going against the MAINSTREAM of Hispanic society. She wanted to be different. She wanted to be an INDIVIDUAL. . .

asked, 'Is this a valuable teaching method?' And 89% wished to continue learning via mobile phone e-mail. Sixty-nine percent indicated the small screen size was not a problem.

We sent three messages each day and assumed students would read our messages as they arrived, but only 10% of our subjects reported reading our messages three times a day. Thirty-three percent read our messages two times a day, and the majority (57%) read our messages only once each day. Subsequent interviews found that students tend to postpone reading our foreign-language messages until they have time to concentrate on them, typically while commuting home from school. Thus we enjoyed limited success in promoting carefully timed interval study.

We conducted two experiments comparing the educational effectiveness of these lessons as delivered by various mobile media. Experiment 1 used a counter-balanced, within-subjects design. Thirteen subjects studied two sets of messages. Each set learned 10 vocabulary items over a 2-week period. We e-mailed lessons to half the students' mobile phones, and encouraged the other half to study identical materials on an identical schedule, materials that we had posted on our mobile-phone website. After

Table 7. Effect of media on test scores

	Experiment 1		Experiment 2	
	Web $N = 13$	Mail $N = 13$	Paper $N = 43$	Mail $N = 25$
Pre-test	1.3	1.1	1.1	2.1
Post-test	4.5	7.8	3.8	6.4
Gain	3.2	6.7	2.7	4.3
g (%)	35	75	31	55

'Pre-test' and 'Post-test' are the average scores before and after students studied identical materials via mobile e-mail, mobile Web, and paper. 'Gain' is the difference between post- and pre-tests. 'g' is the percent of words learnt, i.e., words missed on the pretest but known on the post-test. In both experiments, using both measurements, mobile e-mail performed significantly better.

2 weeks, the two groups switched media for another two weeks. We calculated each media's average gain (= post-test–pre-test scores, or the number of words learned) and g (= gain/[10 − pre-test], or the percentage of unknown words actually learned). By both measurements, students studying via mobile e-mail learned significantly more. (A one-tailed paired t-test comparing gains found $t = 4.16$, df = 12, $P = 0.001$. A one-tailed paired t-test comparing
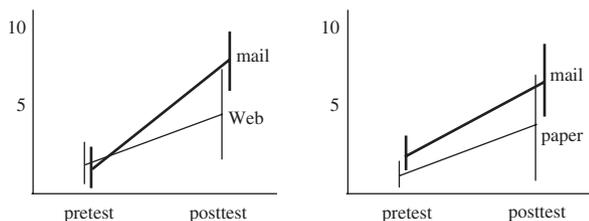
Fig. 1 Effect of media on test scores. Graphs show the average scores and standard deviations of pre- and post-tests for students studying identical materials via mobile e-mail, mobile Web, and paper. Mobile e-mail performed significantly better.

g values found $t = 4.95$, df $= 12$, $P = 0.0003$) (Table 7, Fig. 1).

In Experiment 2, two groups of students studied identical materials for 2 weeks. We sent messages to one group's mobile phones, and encouraged the other group to study identical messages we had printed on paper and distributed to the students. Again, students studying by mobile e-mail learned significantly more. (A one-tailed independent t-test comparing gains found $t = 3.04$, df $= 66$, $P = 0.0034$. A one-tailed paired t-test comparing g values found $t = 3.65$, df $= 66$, $P = 0.0005$) (Table 7, Fig. 1).

These findings suggest that the students who were frequently sent e-mail were prodded to study more often than students encouraged only once a week to study the Web- and paper-based materials, and that this more frequent study led to better learning.

In summary, this first stage of the LOTM project found that delivery of foreign language vocabulary lessons via mobile phone e-mail is effective and received positively by Japanese university students. This method takes advantage of the push aspect of mobile technology, and promotes regular study.

However, student feedback indicated that many students postponed reading their LOTM messages. They were often unable to concentrate on the task during the day when they had only a small chunk of time. Students postponed studying until they had distraction-free time to concentrate in a foreign language. This often turned out to be during their commute home. In the next phase of our investigation, we compared long and short versions of the same vocabulary lessons. We hoped shorter versions would be easier to read, but feared the shortened context would hinder language learning. Here are examples messages introducing the word *vision:*

Long version:

Hi. I hope everyone had a nice summer vacation. Today's word is VISION (視覚). VISION is the same as eyesight. Do you have good VISION or do you have to wear glasses? Today, people with bad VISION can have eye surgery to improve their eyesight. Then they have good VISION and can throw away their glasses or contact lenses.

Short version:

Today' word, VISION (視覚), is the same as eyesight. Do you have good VISION or do you have to wear glasses?

In a 2-week counter-balanced, within-subjects study, half the students received short messages for 1 week, and half received long messages. In the second week, students received messages of the opposite length. The test results showed there was no significant difference in learning between the short and long messages. (A two-tailed t-test for gain gave $t = 0.08$, df $= 28$, $P = 0.94$. For g scores, $t = 0.07$, df $= 28$, $P = 0.93$). This suggests that the effect of regular study encouraged by e-mail is more important than the details of the lessons, but further investigations are still needed to fine-tune LOTM, optimizing message length, frequency, content, and other characteristics, and measuring their effects on learning.

Video and Web materials via mobile phones and PDAs: vidioms

Idioms are highly contextualized phrases that are often difficult for foreign language learners to master. Many idioms are comprised of language that lends itself to visualization through animation and video. To help students understand the meaning and context in which various idioms are used, we created a series of Web pages. Each page presents one idiom (e.g., 'He has a big mouth.') first explaining the idiom's meaning in the students' first-language (L1; Japanese, in our case), then showing a computer animation illustrating the literal meaning (e.g., a character with an unusually large mouth), and presenting a second-language (L2; English) script and live-action video showing the idiomatic meaning (e.g., a person who talks too much, giving away secrets). A final quiz checks students' understanding.

A number of studies assert the convenience and usability of mobile devices as instructional delivery tools for text and images (Sharples 2000; Ericsson 2001; Gustavsson *et al.* 2001; Ring 2001; Rodriguez *et al.* 2001; Soloway *et al.* 2001). We wanted to investigate their usability for multimedia including animation, video, and sound.

Experiment

First instructors and then teams of 3rd and 4th year college students wrote L1 explanations (in Japanese) of English idioms and L2 scripts demonstrating idiomatic meanings, and then created 15-second videos and computer animations to illustrate them. Instructors wrote multiple-choice quizzes to evaluate students' understanding of the idioms, and constructed a mobile phone-sized website to present the materials. 'Hit the ceiling' can be seen in Fig. 2.

Next, students used and evaluated these materials. As part of a class on the evaluation of language-learning technology, 31 college sophomores spent ten minutes looking through the Vidiom website on mo-bile phones and PDAs. (Each student was presented with either a video-capable mobile phone, or a PDA preloaded with the Vidioms Web site.) Students immediately started exploring the website and were unwilling to stop. We hypothesize a strong novelty effect coupled with the visual appeal of brightly coloured animations and lively skits. Students then answered 21 questions using 10-point Likert scales, evaluating various aspects of the hardware, Web pages, videos, sounds, educational effectiveness, and overall reaction. Scores averaged 6.7 on a scale from 0 to 9. All scores were significantly positive (one-group t-tests comparing each question with an expected mean of 4.5 gave $P < 0.05$ for every question). All scores were similar between users of cell phones and PDAs, except that students using PDAs gave significantly higher ratings to *video quality, learning idioms,* and *studying idioms* (each $P < 0.05$). The PDA has a larger, brighter screen, with four times the number of pixels, and five times the video bitrate (the PDA showed 264 kbps mpeg1; the mobile phone displayed 50 kbps mpeg4). Students using PDAs generally gave higher ratings than students using mobile phones, but no other

Fig. 2 Example pages from the Vidiom website, showing a list of idioms, and, for each idiom, explanations, quizzes, and videos showing literal and idiomatic meanings.

Table 8. Evaluation of Vidioms website, by students viewing the site on PDAs and mobile phones, reported on a scale of 0–9, where 9 = agree; 0 = disagree

Questionnaire item	PDA		Phone	
	M	SD	M	SD
Overall Evaluation				
Wonderful (0 = terrible, 9 = wonderful)	8.0	1.0	6.9	1.7
The system was easy to use (0 = difficult, 9 = very easy)	6.1	1.8	6.3	1.9
Satisfying (0 = frustrating, 9 = very satisfying)	7.1	1.2	6.4	1.6
Interesting (0 = boring, 9 = very interesting)	7.6	1.4	7.7	1.4
Screen				
Text was easy to read	7.4	1.7	7.3	1.6
Videos were clear	7.6	1.3	6.1	1.9
It was easy to navigate between pages	6.4	1.1	7.2	1.8
Information was clearly organized	6.4	1.0	6.1	1.6
The sequence of screens was easy to understand	7.0	1.4	6.3	1.7
The use of color was clear	7.4	1.1	7.2	
Sound				
The sound was very clear	7.1	1.6	6.7	1.7
Instructions				
I easily knew what to do	8.0	1.2	6.7	2.1
Learning				
This software will help me learn English idioms	8.3	1.0	6.8	1.5
I can remember all the English idioms I studied using this software	6.9	1.1	6.0	2.0
Overall, this software is good for studying English idioms	8.3	0.8	7.2	1.6
Mobile phones are good for studying vocabulary	5.7	1.2	6.7	1.7
Mobile phones are good for practicing listening	2.3	2.5	5.7	2.0
Mobile phones are good for watching videos in English	4.0	3.6	5.1	1.9
PDAs are good for studying vocabulary	7.3	1.7	6.5	1.5
PDAs are good for practicing listening	5.9	3.0	6.0	1.4
PDAs are good for watching videos in English	6.9	3.1	6.6	1.4
Average	6.8	1.6	6.5	1.7

Significant differences between ratings by PDA and mobile phone users are starred.

scores differed significantly between the devices. (See Table 8.)

Students finished their evaluations by writing their positive and negative impressions in separate blanks. Tables 9 and 10 overview these comments.

Many students found the site enjoyable, and felt it an effective study aid. Several students applauded specific animations.

Students reported difficulty hearing the audio on both PDAs and cell phones; some suggested headphones might help. Students reduced volume to avoid disturbing neighboring students, and felt headphones would be required when studying in trains and other public places. The sound quality, compression technology, and bitrate on the mobile phone are similar to normal wireless voice calls, and seem inadequate for careful listening to a second language.

These complaints about the sound, as well as others concerning the opacity of some videos, are probably at least partially because of the fact that some of the script writers and actors were not native speakers, and semester time constraints did not allow for adequate editing and revision. The Achilles heel of video and 3D animation is the time they require to prepare.

But overall we see few serious technical limitations to widespread use of mobile video technology in education. We heard few complaints about the mobile phone's tiny screen, the 5–10 s wait for video download, and the tiny controls on mobile phones. PDA users reported none of these problems. One student summarized, saying 'I can see how the large screen, superior audio, and efficient stylus interface make the PDA a better learning tool in the classroom. But the small size and one-handed operation of a mobile

Table 9. Positive comments about Vidioms website

Category	Frequency (%)	Example comments
Helpful for study	38	Easily understood and remembered
		The video depiction of the two meanings was very clear
		Videos are more evocative than text
		Watching videos makes the meaning transparent
Fun	25	Videos were very interesting
		I like watching videos
		It was fun
Specific animation	19	Kick the bucket
		Money talks [Coins greeting each other]
Attractive	16	The videos are very colorful and cute
		The video was surprisingly clear
Ubiquity	9	With this I can study everywhere
Legible	3	Words are easily read

Table 10. Negative comments about Vidioms website

Category	Frequency (%)	Example comments
Audio poor	29	Difficult to hear clearly
		Animations are too loud; conversations too quiet
Screen too small	16	Screen is small, so I am tired to see
		It's difficult to watch screen
Specific idioms	12	Animation is obscure to me
		Bite the dust
Download slow	6	It takes time I don't like waiting
Awkward	6	Mobile phone buttons are very small. Difficult to use
Video poor	3	Video quality was rather poor

phone will probably make it the better choice when walking around outside the classroom.'

Conclusion

Our poll shows that Japanese university students use mobile phones often for sending and receiving e-mail, sometimes concerning their classes. They less frequently access the Web from their mobile phone but, when they do, it sometimes relates to their university studies. However, they think that receiving information about their classes via mobile phones is an important potential use.

When actually using educational materials designed for mobile phones, students evaluated them positively, and test results showed that they were able to learn via this medium. The two projects described in this paper, *Learning on the Move* and *Vidioms*, show that mobile devices such as phones and PDAs can be effective tools for delivering foreign language learning materials to students. The two studies show that Japanese university students are comfortable reading text and viewing video on small screens. Rich multimedia can capture their interest, and pushing study opportunities at students via mobile e-mail is effective in helping them acquire new vocabulary. Our investigations suggest mobile devices can be effective tools for a broad range of educational activities.

Future Work

We plan to add *interactivity* to *Learning on the Move* materials, to provide productive as well as receptive language practice. One activity we plan to add is a set of quizzes for mobile phones, quizzes similar to those found at BBC Bitesize Revision (2004). Their research indicates the popularity of these quizzes as a review exercise for high school students (Jones 2004). Providing more variety in the types of activities should engage students and promote long-term retention of target language structures.

We are also investigating the feasibility of using mobile devices as *writing* tools for taking notes and composing essays and reports, by measuring how comfortably and rapidly students can write text using various mobile interfaces, such as handwriting recognition, onscreen keyboards, and tiny keypads (Houser & Thornton 2004). Anecdotes suggest that Asian college students may enter texts faster on mobile phones than on desktop computers, but research into input devices suggests other mechanisms might be even faster, so we are also studying how rapidly students can learn novel input methods.

We are continuing our investigation into the educational efficacy of various *media* on mobile devices: Currently we are developing Flash movies to present foreign language materials on mobile phones and PDAs, and in the future we plan to investigate Web sites and Java programs allowing students to use educational simulations and games on mobile devices.

A final open question is the impact of economic and *cultural issues* on the effectiveness of mobile learning. Japanese students may have unique attitudes towards learning, and towards mobile technology, unique access to technology, and unique patterns of using mobile technology. Our poll and experiments should be replicated and compared with students from other cultures, to help determine the potential effectiveness of mobile education around the world.

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