Japanese college students' typing speed on mobile devices

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Abstract

In previous work on mobile learning, students used cellphones and pocket computers (PDAs) primarily to view study materials and answer quizzes. But anecdotes imply that Japanese students type faster on cellphones than on desktop PCs, suggesting that students could use mobile devices to take notes and write reports. This paper is a first quantitative investigation into the ability of Japanese students to enter text on mobile devices.

In 2-minute transcription tasks, 24 Japanese university students typed Japanese:English at 8:7 wpm on miniature QWERTY thumb keyboards, 10:9 on onscreen QWERTY keyboards, 17:5 on cellphones, 23:14 on desktop PCs, and 31:30 with pencil and paper. 5-minute composition speeds were slightly less in the student's native Japanese, and about half in English. Transcription errors were rare in Japanese, but more frequent in English, especially on mobile devices. Students preferred typing on desktops and cellphones.

This data suggests that Japanese students could take notes and write reports on their mobile phones, but would require training before using PDAs and writing in English. Future work includes longitudinal studies learning various input methods, including handwriting recognition.

1. Introduction

Handheld computing devices, such as mobile phones and pocket-sized 'PDA' computers, show great promise for education. But critics refer to the awkwardness of mobile text input. Is mobile input awkward for Japanese? Because of everyday use of mobile phones and handheld games, Japan has been labeled a 'thumb culture' (Emerson, 2001). We set out to compare Japanese students' input speeds in on a variety of mobile keyboards. First we investigated previous work on mobile education and input.

Mobile Educational Media. Previous work shows that mobile devices allow students to conveniently view educational materials. Ring (2001) found that students enjoyed reading course outlines and texts on mobile phones while commuting. Thornton & Houser (2001) found that students receiving frequent emailed lessons on their mobile phones learned more than control groups urged to study identical lessons on web or paper. And Thornton & Houser (2003) found that students rated highly web and video teaching materials viewed on mobile phones and PDAs. We see that mobile devices support the flow of information from instructors to students.

But little research has investigated the use of mobile devices to submit information from students to instructors. Dufresne, et al. (1996) described the ClassTalk system, in which students use networked PDAs to answer quizzes during short breaks in lectures, allowing lecturers to immediately view students' responses, and adjust the lecture to correct any misconceptions. This idea was re-implemented using wireless PDAs (Chen, Myers, & Yaron, 2000), custom-built infrared transmitters (Huang, et al. 2001), and students' mobile web phones (Thornton & Houser, 2003). All these systems allow students to answer multiple-choice questions. Could these quizzing systems be extended to accept write-in-choices, fill-in-the-blank quizzes, or detailed rationale explaining why a student chose her response? Can students conveniently use mobile devices to enter text? What about paragraphs and essays? Soloway (2001) describes several programs allowing students to use PDAs to draw concept graphs and write reports. But in spite of these technology-driven research efforts, many educators are still skeptical that students will be able to compose texts on mobile devices.

This paper is a first quantitative investigation into the usability of mobile devices for entering texts. It reports on our experiments measuring the input speed, error rate, and preferences of Japanese college students entering text on various mobile devices.

Mobile Input. Researchers have predicted and measured input speed on mobile devices. Researchers evaluate users' performance in psychometric experiments. But such experiments are costly and difficult to generalize because the subjects, tasks, phrases typed, length of the test, and many other factors can profoundly affect the results. So many researchers augment experiments with mathematical predictions, using Fitts' (1954) law to estimate *expert* typing speed (MacKenzie, 1992), and Hick's (1952) law to estimate *novice* speed. Below we summarize previous research on mobile input.

Proceedings of the The 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE'04)
0-7695-1989-X/04 $ 20.00 © 2004 IEEE

Mobile phone keypads. The twelve-button keypad on cell phones is the most commonly used mobile input device: Each day millions of users tap out one billion short email messages (GSM, 2003). Silfverberg, MacKenzie, and Korhonen (2000) predict that experts thumb 24.5 wpm. But James and Reischel (2001) found that both new and experienced users thumbed at only 8.0 wpm. They shows the fallibility of predictions, and the sensitivity to experimental conditions: Newspaper copy was thumbed at 5 wpm, but typical 'chat' at 10 wpm.

Thumb QWERTY keyboards. Some mobile devices sport miniature QWERTY keyboards operated by two thumbs. Although the keys are too small to allow touch typing, users can transfer their familiarity with the QWERTY layout. MacKenzie & Soukoreff (2002) predicted expert performance of 60.74 wpm. This astonishing prediction begs for testing.

Onscreen QWERTY keyboards. Some PDAs display a picture of a keyboard on their touch-sensitive screen. Users input text by tapping on the displayed virtual keys. MacKenzie, Zhang, and Soukoreff (1999) predict novice speeds of 9 wpm, and expert speeds of 43 wpm. MacKenzie and Zhang (1999) conducted a longitudinal test, finding that onscreen QWERTY typists went from 28 to 40 wpm in 20 practice sessions of 20 minutes each. The authors regressed their experimental data to a power law of learning, modeling the wpm after s training sessions as $27.6\ s^{0.124}$. This extrapolates to 45 wpm after 17 hours of practice. Zhai, Sue, and Accot (2002) ran another experiment, extrapolating an expert prediction of only 34.2 wpm. These differing predictions again demonstrate the sensitivity to the experimental parameters, and call for more realistic experiments.

Desktop keyboards. (Since the standard QWERTY keyboard connected to a desktop PC is the most commonly used input method, our experiments use one as a control.) Users typically hunt and peck 20 to 40 wpm or touch type 40 to 60 wpm (Card, Moran, & Newell 1983).

Pen and Paper. (As a second control we measure writing speed using pen and paper, since this is the incumbent, the input method all students use for noting in our current classes.) Most people handwrite at 15 to 25 wpm (Card, Moran, & Newell 1983).

Summary. Table 1 shows, for various devices, the input speeds predicted for experts, and measured by experiments:

Table 1. Input speeds of various devices

WPM	Desktop	Thumb	Onscreen	Cellphone	Paper
Predicted		61	32, 45	25	
Measured	40-60		40	8	15-25

2. Japanese input

Previous research addresses typing English on mobile devices. We wish to investigate mobile typing in Japanese, as well as the typing of English as a second language by Japanese college students.

Typing Japanese on a PC. Asians have experimented with various techniques to input their thousands of characters, but today most Japanese type indirectly using a standard QWERTY keyboard. Japanese first type the phonetic reading of a word, using the English alphabet. Then Japanese choose the written form from a menu of homonyms (words average 10 ideographic writings, but some very common utterances exceed 100 written forms). On mobile devices, onscreen and thumb keyboards are similar to desktop PCs, sporting similar key layouts, and similar typing and menu mechanisms. Europeans feel that the desktop QWERTY keyboard is the undefeated champion of input devices, but many Japanese feel differently.

Typing Japanese on a mobile phone. In both English and Japanese, cellphones arrange their keys in alphabetical order. In contrast, the desktop QWERTY arrangement seems random. Some Japanese postulate that the logical arrangement of cellphone keys make them easier to learn than PCs. Kuroda (2000) says 'America ... is the anomaly. Most of the people in the world never have and never will use a QWERTY keyboard ... The billions of ... wireless email messages thumbed every day are mostly written by ... Japanese: their first and only messaging device is a cellphone ... [K]ids have been clocked ... at messaging upwards of 60 words per minute.' Kuroda argues that such speed comes from extensive practice using keypads, as most Japanese spend many hours each week commuting on crowded public transportation, and those hours are increasingly being used to tap out email on mobile phones.

In any event, because the processes used to enter Japanese are so different on mobile phones and PCs, and also so different from those used to enter English, we doubted the input-speed predictions of earlier work would apply. Further, we expected that Japanese would be slower typing English than native speakers, not only because of their unfamiliarity with English, but also because the processes they use to input the two languages are so different. For example, we observed that most Japanese are familiar with the QWERTY layout, having been trained to touch-type, but have little experience typing English, and seemed to prefer inefficient techniques, such as typing first in Japanese and then changing to an English writing.

3. Experiment

We asked subjects to transcribe and compose on various input devices, in their native Japanese and in English. We used a within-subjects design and counterbalanced the order of entry methods to avoid learning effects. The independent variables are the type of mobile device (e.g., mobile phone or PDA with thumb keyboard), the language (L1=Japanese or

L2=English), and the task (transcription or composition). The dependent variables are the input speed in wpm, error rate, and the subjective opinions of students about the use of mobile devices for educational input tasks.

Subjects were 24 Japanese university students. All were paid volunteers, female, with ages ranging from 18 to 22 and averaging 20 (10 freshmen, 5 sophomores, 7 juniors, and 2 seniors). Half studied foreign languages, and half studied computers. On a pre-experiment questionnaire, subjects reported using PC email for a mean of 41 months and mobile phone email for a mean of 40 months. Students reported composing on PCs an average of **2.1** emails and papers per week (range 0-5) and composing **66 mobile phone emails** per week (range 10-280). None of the students reported owning or using a PDA. Students had taken an average of 8.2 English classes (range 0-18).

Apparatus included the students' own cellphones, paper and pencil for handwritten text, a desktop PC running Windows 95 with a standard QWERTY keyboard, several PDAs (Sharp Zaurus A300, Palm V, Palm m505, and Compaq iPaq) for onscreen keyboard input, and a Targus 'Snap N Type' thumb keyboard.

Figure 1. Apparatus.

Texts. For transcription tasks, we selected a Japanese (L1) paragraph explaining Valentine's Day, and wrote an English (L2) paragraph using common topics and an appropriate language level for our high beginner English language students. Both were standard academic paragraphs for foreign language (L2) and culture (L1). For composition tasks, we chose topics that are commonly used in beginning-level foreign language learning: self-introductions, family, high school, hobbies and clubs.

Procedure. Subjects first completed a Pre-Experiment Poll about their experience using mobile devices and desktop computers and giving their opinions about the use of those devices for educational tasks. Subjects were then given brief instructions about the task and instructions on the use of the PDAs. No subject had prior experience using PDAs. Subjects were encouraged to enter a few phrases in English and Japanese on each of the PDAs. Examiners answered any questions. Then subjects were told that their speed and accuracy would be measured, and that they should type as rapidly as possible, and correct any errors they find.

Students were rotated at random through the devices and completed a series of 2-minute transcription tasks (alternating L1 and L2 on the same device) followed by one 5-minute composition task in each language. Text to be transcribed was provided to the subjects on paper. The experimenters used a stopwatch to keep time. When time was called, subjects were instructed to stop typing and to save their work on the PDAs and desktop PC and to email their work to the examiner from their mobile phone. When all subjects were ready, the next task was begun.

Finally, all subjects answered a Post-Experiment Questionnaire indicating their opinions of the mobile devices and their appropriateness for educational input tasks.

Errors. Subjects were told to correct any errors they made; Their goal was an error-free text. Later, we counted any remaining uncorrected mistakes.

Measurements. We measured input speeds for transcription (in L1 and L2) and analyzed errors. We measured input only speeds for composition (in L1 and L2), since there could be many possible reasons for errors, especially in a foreign language.

English typing speed is reported in 'words per minute', defined as c*12, where c is typing speed in characters per second (WPM = c*60/5). This formula assumes a 'word' is five 'characters' (= letters, punctuation symbols, and blanks); this corresponds only approximately to actual words. So WPM actually measures *characters* typed, not words.) The formula is simple to apply to typing English on a QWERTY keyboard, since each *keystroke* (button pressed on the keyboard) results in a single onscreen *character.*

We extend the WPM measurement to other languages and devices, where we often need multiple keystrokes to produce a single onscreen character. For example, typing 'HELLO' on a typical 'multitap' cellphone requires 14 keypresses (2 for the H, 2 for the E, 3 each for the Ls with a right-arrow keypress between them, and 3 for the O). For English on cellphones, we decided to ignore the extra keypresses and just count the number of characters entered. This simplifies comparing English typing speeds on various devices. We measure the result, ignoring the effort various devices demand to produce it. But that means when students type on cellphones, their actual speed of input (in terms of keypresses per second) is higher than reflected in our comparison. As educators we are interested in the amount of text (characters) that can be produced rather than the literal physical input speed.

We also extended the WPM definition to Japanese. Since Japanese language does not use spaces between words, and the boundaries between words can be ambiguous, we decided to count characters, as in the English WPM. Each Japanese character requiring some number of keystrokes to enter; The number depends on the character and on the input device. For example, Japanese type the two Japanese characters for 'Tokyo' using 8 English letters on a QWERTY keyboard (Toukyou_), or 19 taps on a Japanese cellphone (using the typical 'kana multitap' system). In order to compare English and Japanese input on QWERTY keyboards, we count Japanese keystrokes (not characters). When our test subjects type 'Tokyo' we count that as 8 letters.

The controversial aspect is that we use the same keypress count (8) on all devices, even non-QWERTY devices like cellphones and paper, where the keystroke count is different, or the very concept of keys meaningless. Our rationale is that this commonality allows us to compare Japanese output across devices. In summary, we analyze Japanese typing speed by deconstructing written text back into the keystrokes required to produce it on a QWERTY keyboard, and then using the WPM formula. We posit this will give us comparable numbers, even across different input devices and radically different languages.

We also calculated, using our transcription texts, the ratio of cellphone keypresses to QWERTY characters, and found that for Japanese there was a 1.7 ratio and for English 4.1.

4. Results

Paper and pencil were fastest. Desktops were the second fastest. When typing Japanese, cellphones were only slightly slower than desktops (Figure 2).

Composition was slightly slower than transcription in L1, and much slower in L2 (Figure 3). Errors were much more common in L2 than in L1 (Figure 4). Subjects preferred typing on their familiar cellphones and desktops. The novel input methods were less well liked (Figure 5).

The thumb keyboard was slow and unpopular. During the experiment, we observed students confused by its cryptic keycap symbols. They forgot how to type punctuation, and accidentally pressed function keys, occasionally switching to another application, and sometimes erasing their text. We feel that with a few more minutes of training and practice, subjects would learn to make far fewer errors using thumb keyboards.

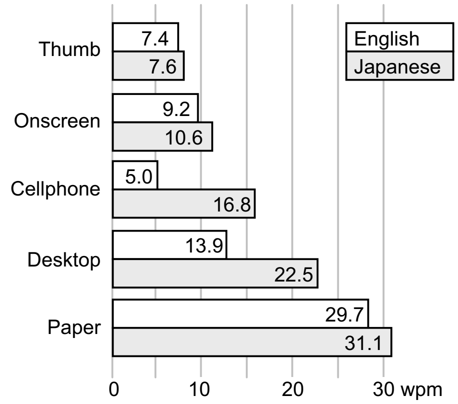

Figure 2: Transcription speed on various devices in L2 (English) and L1 (Japanese).

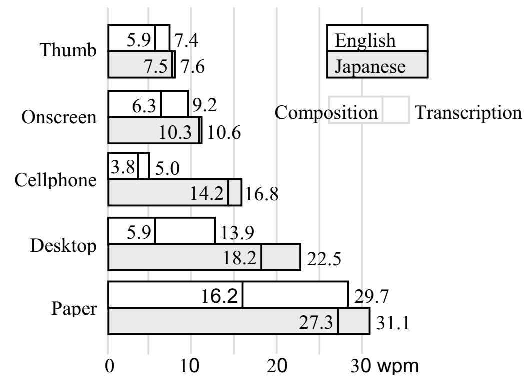

Figure 3: Composition vs. transcription speeds.

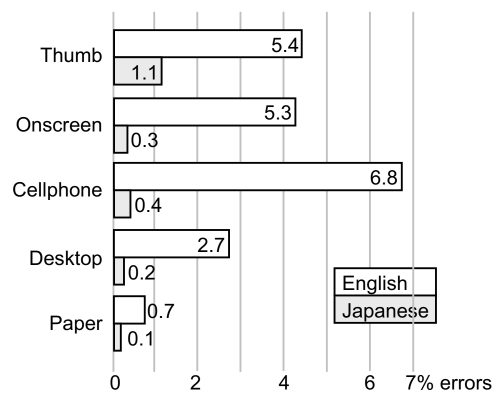

Figure 4: Transcription errors.

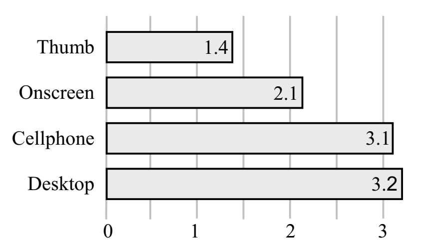

Figure 5: Preferences for mobile input devices.

5. Discussion and Conclusion

We measured the speed, accuracy, and preferences of Japanese students typing both English and Japanese on several mobile input devices. We found that with practice, small mobile keyboards, like those found on cellphones, can be capable input devices. We believe Japanese students are expert users of cellphone keypads in the Japanese language (Thornton & Houser, 2004), but novices on PDAs and in English. What does this mean for education?

In university classrooms, one finds both transcription and composition tasks. Transcription tasks include copying notes from slides, blackboards, and texts. Composition tasks include summarizing lectures and texts, writing essay, reports, and presentations, and creative writing such as L2 fiction and journals. Based on our data, we believe that Japanese students could easily accomplish both transcription and composition tasks in their native Japanese language with their readily available cellphones, without any training or additional practice. However, if instructors wish to use foreign languages, or wish to adopt other mobile technologies such as PDAs, some training and practice time will be needed before the tools can become useful input devices.

The dominance of paper and pen over electronic input devices surprised us. Certainly it would be hard to find many American college students who could handwrite faster than they could type. We posit that Japanese students have years of experience transcribing English and Japanese texts to paper throughout high school and college, and only infrequently use computers. Pen and paper are approachable, but the medium deprives students of the advantages of electronic media (easy storing, searching, editing, printing, and exchanging). Mobile devices are especially advantageous for students, because they make notes and assignments available whenever students have a few moments to study.

As a future project, we plan a longitudinal study, giving students more time to become accustomed to novel input methods such as onscreen and thumb keyboards. We also hope to train and test students on the use of a handwriting recognition system on PDAs, such as Palm's *Graffiti*, as a possible way to capitalize on Japanese students' handwriting abilities, and to combine the accessibility of the pen with the benefits of electronic text for Japanese students.

References

Card, S. K., Moran, T. P., and Newell, A., Th Psychology of Human-Computer Interaction, Lawrence Erlbaum, 1983.

Dufresne, R. J., Gerace, W. J., Leonard, W. J., Mestre, J. P., & Wenk, L. (1996). Classtalk: A Classroom Communication System for Active Learning. Journal of Computing in Higher Education, Vol 7, pps 3-47.

Emerson, T. (2001, August 6). The next big thing? Newsweek, 23-25.

Fitts,P.M. (1954). The information capacity of the human motor system in controlling the amplitude of movement. Journal of Experimental Psychology, 47, 381-391.

Franklin Chen, Brad Myers and David Yaron, (2000). Using Handheld Devices for Tests in Classes. Carnegie Mellon University School of Computer Science Technical Report, no. CMU-CS-00-152 and Human Computer Interaction Institute Technical Report CMU-HCII-00-101. July, 2000.

Hick, W. E. (1952). On the rate of gain of information. Quarterly Journal of Experimental Psychology, 4, 11–26.

Huang, C., Liang, J., & Wang, H. (2001). EduClick: A computer-supported formative evaluation system with wireless devices in ordinary classroom. ICCE 2001: International Conference on Computers in Education. Seoul, Korea, 1476-1483. www.icce2001.org/cd/pdf/p13/TW037.pdf

James, C. L. & Reischel, K. M. (2001), Text input for mobile devices: comparing model prediction to actual performance, in Proceedings of CHI2001, ACM, New York, pp. 365-371.

Kuroda, R., (2000). Enough Already! Cellphones are not Unwieldy, Japan Inc. November 1, 2000, www.japaninc.net/online/sc/ren/nov00_sc_screen.html

MacKenzie, I. S., & Soukoreff, R. W. (2002). Text entry for mobile computing: Models and methods, theory and practice. Human-Computer Interaction, 17, 147-198.

MacKenzie, I. S., & Zhang, S. Z. (1999) The design and evaluation of a high performance soft keyboard. Proceedings of the ACM Conference on Human Factors in Computing Systems – CHI '99, pp. 25-31. New York: ACM.

MacKenzie, I. S., Nonnecke, B., McQueen, C., Riddersma, S., & Meltz, M. (1994). A comparison of three methods of character entry on pen-based computers. Proceedings of the Human Factors and Ergonomics Society 38th Annual Meeting, pp. 330-334. Santa Monica, CA: Human Factors Society.

MacKenzie, I. S., Zhang, S. X., & Soukoreff, R. W. (1999). Text entry using soft keyboards. Behaviour & Information Technology, 18, 235-244.

MacKenzie,I.S. (1992). Fitts' law as a research and design tool in human-computer interaction. Human-Computer Interaction, 7, 91-139.

Ring, Geoffrey. (2001). Case study: Combining Web and WAP to deliver e-learning. Learning Circuits. Retrieved on July 2001, from www.learningcircuits.org/2001/jun2001/ring.html

Shumin Zhai, Alison E. Sue and Johnny Accot. (2002). Movement Model, Hits Distribution and Learning in Virtual Keyboarding, Proceedings of Conference on Human Factors in Computing Systems - CHI 2002. New York, ACM. 2002, p. 17-24

Silfverberg, M., MacKenzie, I. S., & Korhonen, P. (2000). Predicting text entry speed on mobile phones. Proceedings of the ACM Conference on Human Factors in Computing Systems - CHI 2000, pp. 9-16. New York: ACM.

Soloway, E., Norris, C., Blumenfeld, P., Fishman, B., Krajcik, J., & Marx, B. (2001). Handheld devices are ready-at-hand. Communications of the ACM, Vol. 44, No. 6, 15-20.

Thornton, P. & Houser, C. (2001). Learning on the Move: Foreign language vocabulary via SMS. ED-Media 2001 Proceedings, 1846-1847. Norfolk,Virginia: Association for the Advancement of Computing in Education.

Thornton, P. & Houser, C. (2003a). EduCall: Adding Interactivity to Large Lecture Classes in Japan via Mobile Phones. In Lassner, D. & McNaught, C.(Eds), Proceedings of ED-MEDIA 2003 pp. 1871-1874.

Thornton, P. & Houser, C. (2003b). Using Mobile Web and Video Phones in English Language Teaching: Projects with Japanese College Students, ITMELT 2003 Proceedings (2003).

Thornton, P. & Houser, C. (2004). Using Mobile Phones in Education. 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education, March, 2004, Taiwan.