# THE INFLUENCE OF MPBILE INPUT TECHNIQUES FOR TOUCH SCREEN DEVICES ON THE PERFORMANCE OF JORDANIAN POPULATION

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**Abstract:** This paper reports the results of a study on two different mobile text input methods on PDA's that most people use in Jordan. The effects of two tapping techniques (single and multi-tap) on the speed and accuracy of entering text with a mobile touch screen device were investigated, in an experimental study on 22 Jordanian females. Subjective opinions on how each of the methods affects learnability, accuracy, and efficiency of text entry were also investigated. The results indicated that the single tap method was faster and more accurate, and was thought of as being easier to learn, less error prone, and more efficient than the multi-tap method, despite the fact that multi-tapping was done on a larger keypad with greater space for the fingers.

## 1. INTRODUCTION

Sending electronic messages by texts via mobile phones, instead of via a desk top or laptop computer is ubiquitous in industrialized societies. It is also fairly widespread even in underdeveloped countries. The transmission of short textual messages (SMS texting) between mobile phones via the Wireless Application Protocol (WAP) to other systems and devices has been increasing exponentially, and integration with other services such as email and web services is also expected to follow the same trend (Dunlop and Crossan, 2000). The different types of devices differ in many respects -- cost, usability, quality, tapping technique, keyboard type, etc. Their uses have been studied to determine, among other factors, the accuracy, ease, speed of use, acceptability, and the safety while driving. Most of these studies have been performed in Europe and the United States; hardly any in the Middle East.

Small, light devices offer the great advantage of portability and privacy, and do not require a workstation setup, or other similar infrastructure, for their use. However, accompanying portability is a host of other factors that affect the speed and accuracy of text input. These pertain mainly to the small size of the keypad that has replaced the full-sized QWERTY keyboard found with desk top computers. Unlike the normal sized computer keyboard, the keypad on mobile phones and PDA's do not conform to the size and functional characteristics of the hand and arm. On the condensed keypad, the user does not have a separate key for each letter, is not able to use both hands for tapping the keys. He or she may also have to deal with the extra cognitive load involved in disambiguating different letters mapped onto the same key. The present study focuses on text messaging on small virtual keypads.

Text messaging is done mostly on PDAs and mobile phones (Riordan et al., 2005) with small keys on miniaturized 10 digit keypads. Alphabetic letters are assigned to each keypad. The keypad may be a physical (or hard) one or a virtual (or soft) one. The latter appears on the screen when the PDA or phone is in use. Text may be entered with a stylus or a finger (the index finger or thumb) and the mobile device may be held with both hands or with one hand. Few designers or researchers have researched text input methods from a user perspective (Riordan et al., 2005), and found that speed and accuracy of text input are significantly different compared to what is achievable on a normal size computer keyboard. Users have been gradually developing their own abbreviations and, hence, distinct texting language based on phonetics to

adapt to the rapid changes in technology. For example, the letter "u" is now commonly used for the word 'you" and 'ur' for 'your,' and so on. While this may be good for conversational communication, it is not necessarily so for more serious exchanges. It is, therefore, important to know what technologies and human behavioral characteristics can be integrated to enhance the effectiveness and efficiency of text input.

The type of errors made and the reasons for making them are varied. Error types include substitution (entering an incorrect character), insertion (entering an extra character), omission (failing to enter a character), and transposition (swapping neighboring characters) (MacKenzie and Soukoreff, 2002). Errors are difficult to measure accurately and some researchers have avoided counting them (Venolia and Neiberg, 1994) while others have forced users to go back and correct them, thus producing error free texting (Lewis, 1999). Various studies (Mackenzie et al., 1999; Fleetwood et al., 2006; Soukoreff and Mackenzie, 2001; James and Reishel, 2001; Mackenzie and Zhang, 1999) have been conducted to determine speed and accuracy of text entry on PDAs and mobile phones. Some are empirical, others are mathematical and use predictive models (Silverberg et al., 2000; James and Reishel, 2001; Dunlop and Crossan, 2000). However, more empirical studies are needed to capture user's behavioral response to this new technology and to determine the validity of some of the mathematical models. The present study is an empirical on the speed and accuracy in text messaging.

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## 2. METHODS

***Objectives*:** This study was conducted to (i) compare the speed and accuracy of two text entry methods using a mobile, and (ii) determine user subjective preferences for the text entry methods from the perspective of ease of use, accuracy, efficiency. The two methods of text entry were single tap and multi-tap. They were defined by two different text input technologies – input via a full QWERTY keyboard and via a condensed keyboard. In the full QWERTY keypad, each key is pressed once to obtain a letter – the single tap method. In the condensed keypad, a key is pressed once for entering the first letter on it and twice for the second letter – the multi-tap method. When pressing twice for a letter, a pause (time-out interval) of 1-1.5 seconds must be made after the first tap, hence the term 'multi-tap.' For example, to enter `ER', the user must press the `1'-key in the sequence 1-11, where a dash expresses waiting for the time-out. The mobile device used for the tests is the HTC Touch Dual. It has a condensed keypad with 12-14 keys and a full QWERTY virtual keypad.

***Subjects**:* Twenty two females, between the ages of 19 to 44 years, volunteered to participate in the study. Five were students from the University of Jordan. The others were employees in IT companies (programmers and engineers). The participants declared themselves as heavy mobile and computer users. All subjects were native Arabic speakers who spoke English as a second language. The subjects were not paid nor were they given any kind of compensation for their participation.

***Text Selections*:** Five English language statements shown below, in Table 1, were used for text entry in the experiment. These were taken from James and Reischel (2001) and Butts and Cockburn (2002) to allow for comparison of results. These phrases were selected because they did not include punctuation or syntax; grammatical properties were not being tested. The short simple sentences were considered suitable for subjects whose native language was not English.

Table 1. Statements selected for text entry

| | Phrase | #Characters |
|---|---|---|
| 1 | what show do you want to see | 28 |
| 2 | let me know if we should wait | 29 |
| 3 | hi joe how are you want to meet tonight | 39 |
| 4 | want to go to the movies with sue and me | 40 |
| 5 | we are meeting in front of the theater at eight | 49 |

***Experimental procedures*:** Subjects were first allowed to hold and practice using the HTC Touch Dual device for text input, using both single tap and multiple tap methods, to familiarize themselves with task and minimize learning effects. They did not practice with the same sentences used for the tests. Their practice times were short, on the average, since they were all familiar with the device. They were tested in a quiet room, with adequate light and comfortable environmental conditions. They were tested individually. Subjects first entered each phrase on the device using either the single or multi-tap, and then moved onto the other input method as soon as all five sentences were typed. They were not allowed rest times between sentences or devices. A timer automatically recorded the starting and stopping times. Subjects were free to use

either their fingers or the stylus for tapping. Since efficiency of input method was being investigated, subjects were asked not to go back and make corrections after entering letters. After the text entry tests, subjects were asked to complete a short questionnaire on their subjective opinions on the entry methods. The questions related to learnability (I find this method easy to earn), accuracy (I did not make any mistakes), and efficiency (This input method is efficient to use). Subjects entered their responses on a 5 point Likert scale (1- strongly disagree and 5 for strongly agree).

***Measurement of Speed and Errors*:** The time for each statement was converted to words per minutes (wpm) by dividing the word length of each text sentence by the elapsed time. A word length of 5.98 characters per word (Dunlop and Crossan, 2000) was used. Errors were classified either as wrong spelling, an insertion, or a deletion. The Soukoreff and Mckenzie's Minimum String Distance statistic (MSD) was used (Soukoreff and Mackenzie, 2001) to calculate the number of errors made in each sentence.

## 3. RESULTS AND DISCUSSION

The speed and error data were analyzed to determine if there were differences on them between the two text entry methods, using Hotelling's $T^2$ test. The results indicated that both of the response variables, speed or error rate, were significantly affected by the input method ($p<0.01$). Follow up analyses were carried out to determine the effect of the two methods on each of the two response variables, speed and error rate. The results showed that (1) text entry by single tap was faster than by multi-tap (12.8 vs 9.3 wpm; $p<0.01$); and error rate was smaller for single tap entry than multi-tap entry (0.013 vs 0.047; $p<0.01$) (Table s 2 and 3). These speeds are slower than the speed predicted by the mathematical model of Silfverberg et al. (2000) but faster than the speeds found by James and Reischel (2001) and Butts and Cockburn (2002), though the comparisons are do perfectly valid due to small differences in methods and devices used.

Table 2**.** Speed of entry (WPM) for the input methods

| | Mean | StDev | Minimum | Maximum |
|---|---|---|---|---|
| Single tap text entry | 12.797 | 3.391 | 6.311 | 21.611 |
| Multi-tap text entry | 9.334 | 11.111 | 3.23 | 78.595 |

Table 3. Error rate for the input methods

| | Average | StDev | Minimum | Maximum |
|---|---|---|---|---|
| Single tap text entry | 0.01310 | 0.02663 | 0.00000 | 0.15152 |
| Multi-tap text entry | 0.04708 | 0.05621 | 0.00000 | 0.26923 |

The greater speed and accuracy gained by using single tapping was most likely due to its simplicity and reduced number of taps per letter entered. Even though there were only two letters, at most, mapped onto a key, the need to tap more than once per letter slowed down text entry considerably. It also seems that the loss in speed from multi-tapping was not compensated for by the advantage gained by using larger keys (on the virtual keypad). Nor did the larger key pad for multi-tapping decrease error rate relative to that from using the smaller keypad for single tapping. Perhaps, males would perform differently.

***Questionnaire data analysis:*** The Friedman non-parametric test was used to analyze the ranked data from the questionnaire for the 22 subjects. The three variables analyzed were learnability, error rate, and efficiency of technique used. The results indicated that subjects felt that the different methods of text entry had significantly different learnability (Friedman statistic, S= 13.14; p=0.001), error rate (S= 7.68; p= 0.006), and efficiency (S= 8.91; p= 0.003). Subjects felt that the single tap method was easier to learn (Rank=4.3 vs 2.7), more efficient to use (4.0 compared to 2.7), and the less prone to errors (3.9 vs 2.5). These results agree with the objective measurements made on speed and error rate, discussed earlier

Table 4. Mean (and s.d.) of responses to subjective opinions on a 5-point Likert scale

| | Single tap | Multi-tap |
|---|---|---|
| Q1. I found this method easy to learn | 4.27 (0.93) | 2.72 (1.38) |
| Q2. I did not make many mistakes with this method | 3.86 (1.24) | 2.50 (0.96) |
| Q3. Overall, this input method was efficient to use | 4.00 (0.75) | 2.68 (1.04) |

It is not known whether subjects would have preferred to use abbreviations, as noted for the subjects of Butts and Cockburn (2001), nor whether they would have been faster or more accurate using abbreviations. It is not know whether there is a gender difference in performance or preferences in these subjects whose second language is English. The present study is being extended to test gender effects. Riordan et al. (2001) found gender differences in speed and error rates using various devices and entry methods.

## 4. CONCLUSIONS

This study supports the generally held view that text entry speed and error rate depend on the method of entering the characters. It also shows that this view is not simplistic. This study did not examine the effect of different types of keypads – physical versus virtual. We cannot assume that the single tap method would be faster also on a physical keypad. It is possible that speed and error rate are better when using single tap on a virtual keypad but not on a physical keypad. A more complex experimental design with more than one main factor (entry method) is needed to test this hypothesis. Designing text input methods should be HCI (human computer interaction) centric. Such designs require both software and hardware improvements simultaneously. This study does not provide answers for many other factors that may influence user preference, accuracy, or efficiency of text input. Nor can mathematical predictive methods necessarily answer these questions. More empirical studies are needed.

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