

# A Case Study of Writing Task Performance: Smartphone Input vs. Handwriting

Bradford Lee<sup>\*1</sup>

<sup>\*1</sup> Organization for Fundamental Education

M-learning (mobile phone-based learning) is quickly becoming prevalent at educational institutions around the world. However, while there have been studies (though few and limited) examining the differences between typing on a computer vs. handwriting, there have been no similar studies investigating smartphone use. This is the first empirical study comparing performance on English writing tasks between the media of smartphones and handwriting, and also the first to investigate using different media for composition in a second language (L2). Writing samples submitted via both media were collected from 2 freshman English majors over a 14-week period and analyzed for word count. Results for both participants showed statistically significant decreases in production when using a smartphone to the effect sizes of  $d=-1.13$  and  $-2.34$ , respectively. This is a significant result that educators should be cognizant of when assigning online tasks. Implications for the classroom and possible ways to mitigate the negative effects of smartphone use are also discussed.

**Key Words** : m-learning, smartphone vs. handwriting, writing tasks

## 1. Introduction

The concept that the medium used for communication may inadvertently affect the quality/quantity of ideas being transmitted is by no means a new one. Throughout history, the ways in which societies have thought about or utilized advancements in communication technologies have constantly shifted, in sometimes surprising ways. Perhaps one of the most fundamental and illustrative examples of these shifts in sentiment can be seen with the advent of writing. While in modern times, reading and writing are commonly thought of as the most academic and scholarly of endeavours, ancient philosophers had serious doubts regarding their use. In ancient times, when learning and culture were based in oral-transmission, oratory skills were considered as highly desirable attributes. Therefore, writing was disdained by such famous philosophers such as Plato, who in his book *Phaedrus* (circa 370 B.C.)<sup>(1)</sup> speculated that dependence on the written word would “create forgetfulness in the learners’ souls, because they will not use their memories; they will trust to the external written characters and not remember of themselves” (*Phaedrus* 275a)<sup>(1)</sup>.

The same pattern can be observed whenever there has been a technological advance; the benefits gained in terms of speed, convenience, accuracy, longevity, range of distribution, etc. usually come at some price, a trade-off of sorts. Most commonly, critics claim that the depth of our cognitive functioning is what suffers. Teachers were even wary of the invention of pencil-top erasers, fearing that the ease with which students could alter their compositions would likely result in increased flippancy of thought before putting pencil to paper (Baron, 2009)<sup>(2)</sup>. Needless to say, these concerns notwithstanding, the march of technology has proceeded ever forward. In due course, the typewriter, the printing press, and the personal computer brought literacy and publishing ability to the masses, forever altering not only how we receive, but also how we ourselves choose to disseminate information. The question is not *do* these advancements in technology have an effect on the communicative ability of users, but *how* are they affected. Now with the lowering cost of owning a mobile device, the complete permeation of society appears imminent. A 2014 white paper commissioned by the Japan Cabinet Office estimated that mobile phones have penetrated 93.2% of households nationwide (Japan Cabinet Office, 2014)<sup>(3)</sup>. As more and more

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<sup>\*1</sup> 基盤教育機構

E-mail: bradford-lee@fukui-ut.ac.jp

schools look to make use of this technology to aid learning (i.e., m-learning), this study sought to analyze the performance of Japanese university students on an English writing task conducted via two media: smartphones and handwriting. The results have direct implications to teachers who will be informed how their use of technology in the classroom affects the outcome of class activities. This study sought to answer the following question: how does the input medium affect the length of compositions produced in English task-writing assignments?

## 2. Review of the Literature

In a 2016 article, researchers made the assertion that “typing is becoming our preferred way of writing” (Pinet, Ziegler, & Alario, p. 1898)<sup>(4)</sup>. Some researchers have even suggested that modern reliance on digital technologies is causing a decline in basic fine motor skills and precise arm-hand movements related to producing written text (Sülzenbrück, Hegele, Rinkenauer, & Heuer, 2011)<sup>(5)</sup>, while lamenting the lack of research in analyzing the cognitive impact of this fundamental shift (Mikulak, 2014)<sup>(6)</sup>. Indeed, at the time of this writing, there has been very little published research on the differences in cognitive effects between the typing and writing by hand. However, what little research that *is* available seems to indicate that there are tangible differences between the two. To start with, evidence seems to suggest that handwriting letters of the alphabet leads to better subsequent letter recognition than typing does in pre-literate children (Longcamp, Zerbato-Poudou, & Velay, 2005; James & Engelhardt, 2012; Kiefer, Schuler, Mayer, Trumpp, Hille, & Sachse, 2015)<sup>(7)(8)(9)</sup>. This trend was also found in adults who were trained to write new characters; the group which was trained by typing was found to make more mistakes in letter recognition than the handwriting group (Longcamp, Boucard, Gilhodes, & Velay, 2006)<sup>(10)</sup>, suggesting that training method directly correlates to recognition/reading proficiency.

Mueller and Oppenheimer (2014)<sup>(11)</sup> considered the matter from a different perspective, that of cognitive processing. Their study, which compared students who took notes on laptops with longhand note takers, found that the group with handwritten notes performed better on conceptual questions than their typing counterparts. While impossible to attribute the exact reason this result occurred, the authors postulated that while typing produced a greater volume of notes than longhand did, the longhand group tended to synthesize the content of the lectures and reformulate notes in their own words. This most likely led to a deeper level of processing than the type-written notes, which showed a tendency to simply be a verbatim account of the lecture (i.e., no reframing of information). However, some researchers note that keyboarding fluency is a major contributing factor which influences the quality of written prose due to the increase demand on higher order processes such as planning and reviewing (Connelly, Gee, & Walsh, 2007)<sup>(12)</sup>, with correlations found between slower typing speed and lower quality of writing. This is a key factor which distinguishes computers from smartphones, for while the keyboard layouts are the same for both machines, smartphone keyboards are so compact that most people usually only use one or two fingers for typing, compared with keyboard typing that uses all 10 fingers (for proficient touch-typists). However, to date, there are no known studies which have analyzed typing speed on smartphones, nor the impact this has on written prose. In addition, most of the published research has been done on native speakers of the language using different media. An extensive search through the literature did not find an empirical study which considered smartphone vs. handwritten prose in a foreign language; EFL (English as a foreign language) in this instance. The additional factor of composing prose in a foreign language should impose even more of a strain on the limited cognitive resources available to a language learner, which is expected to manifest itself in even greater effect sizes than would be seen in a native speaker.

## 3. Study Design

### 3.1 Participants

This study looked to compare the performances of Japanese tertiary students on a series of L2 English writing tasks. As such, it was determined that participants must both have a high degree of proficiency in English and come from a background with extensive formal English education to ensure that they are comfortable with writing in English. As the institution where this researcher is based does not have an English major program, it was determined that the student body would be unsuitable

for this research. Recruitment was therefore carried out at a government-sponsored learning center, where students are known to gather from all around the prefecture. Two volunteers, who were English majors at the prefectural university, agreed to take part in the study, which would last 14 weeks. Both participants were female and in their second semester of their freshmen year, making them 18-19 years old. While neither of the participants had official TOEIC or TOEFL scores from the past 18 months to objectively appraise their English ability, both had excellent oral proficiency in terms of complexity, accuracy, and fluency, and could impressionistically be characterized as being at an advanced-intermediate level. Participant #1 reported that she had five English classes per week (only one taught by a native speaker), and Participant #2 reported that she had four (with one taught by a native speaker). Both students seemed very studious and being from the prefectural university, had achieved exceptional enough grades in high school in order to be able to pass the entrance exam. In addition, both participants reported having owned a smartphone for over five years and being fully comfortable with their use and methods of text-entry. Participant #1 owned an iPhone X and Participant #2 owned an iPhone 8, with screen sizes of 5.5” and 5.8”, respectively, and reported having no problems with Internet-connectivity throughout the day (via WiFi or 4G).

### 3.2 Materials and Methodology

The study consisted of a series of 14 writing tasks; 7 based on paper and 7 based online. The writing tasks consisted of a basic open-ended question, eliciting the students to think about a topic and freely compose their response. Every effort was made to make each writing task of comparable complexity/interest to the students in order to elicit an equivalent level of response (see Appendix). However, no guidance was given to the students as to how much they were expected to write, as the study hoped to investigate how much prose the participants would produce naturally, given similar tasks but under two different media. Word count was chosen as the metric by which to assess writing task performance as the writing tasks were conversationally based, regarding everyday topics. As such, it was not reasonable to assume that there would have been a significant degree of grammatical complexity or lexical variation that would have made a CAF (complexity, accuracy, and frequency) analysis possible. Typically, compositions are broken down into 100-word blocks to analyze for CAF, requiring significantly longer writing samples than what was collected.

The smartphone-based responses were created using Google Forms, the link to which was converted into a QR code and given to the participants each week. The response fields on the Google Forms were deliberately expanded to show 15 blank lines (the default setting is to show only a single blank line, which automatically expands as needed as more text is entered) to avoid any potential misconception by the participants that they could only enter a single line of text. Paper-based tasks were created in the same manner, using Google Forms, but were then printed out on an A4-sized piece of paper in order to stylistically match the design of the smartphone-based tasks. Design, font, illustrations, and layout were therefore identical across all 14 writing tasks.

The researcher met with the participants during the first week and obtained their consent to participate in the study, although the metric by which performance would be assessed (i.e., length of response) was not disclosed. The researcher then met with the participants every week for the remaining 14 weeks of the semester to discuss the responses from the previous week in an English conversation-style lesson, and give out the next writing task for the following week (only discussion of the task was done on the final week). In this study, there were no time limits for the writing tasks, as the participants could take them home and work on them freely throughout the week until the next meeting. There was also no feedback (positive or negative) during the synchronous sessions relating to the length of the responses; only the contents of the compositions were ever discussed. Grammatical or syntactical errors were, of course, corrected when applicable, but assignments were not graded, and these corrections were simply for the benefit of the participants and not related to the results of the study. The assignments rotated weekly between smartphone and handwritten to mitigate such factors as practice effects (e.g., variations in production due to increased familiarity with the task) or seasonal exhaustion.

#### 4. Results

The data collected was entered into a dataset using IBM's Statistical Package for the Social Sciences (SPSS) software, version 24. All statistical data analyses were performed using this software. Tables 1 and 2 below show the word count of the individual writing tasks assigned throughout the study, along with the descriptive statistics produced by both media.

Table 1

*Word Count Summary for All Writing Tasks (Participant #1)*

Task (via Smartphone)	1	3	5	7	9	11	13	<i>M</i>	<i>SD</i>
	11	93	84	138	127	95	102	92.86	40.97
Task (via Handwriting)	2	4	6	8	10	12	14	<i>M</i>	<i>SD</i>
	108	135	91	101	178	166	214	141.86	45.72

Table 2

*Word Count Summary for All Writing Tasks (Participant #2)*

Task (via Smartphone)	1	3	5	7	9	11	13	<i>M</i>	<i>SD</i>
	63	45	92	84	141	93	52	81.43	32.49
Task (via Handwriting)	2	4	6	8	10	12	14	<i>M</i>	<i>SD</i>
	141	179	146	115	165	160	124	147.14	22.76

As can be seen by comparing the mean results in the tables above, both participants produced drastically more English prose on average, when the task was assigned via handwriting, compared to smartphone input. While both participants produced over 140 words on average per handwritten assignment ( $M=141.86$  and  $147.14$ , respectively), the same participants produced less than 100 words when asked to complete assignments via smartphone ( $M=92.86$  and  $81.43$ , respectively). However, within these ranges, both participants showed a large degree of variation between writing tasks, resulting in standard deviations of  $SD=40.97$  and  $32.49$ , respectively for smartphone tasks, and  $SD=45.72$  and  $22.76$ , respectively for handwritten tasks. A t-test was run to determine statistical significance (if any) and effect sizes. These results are presented in Table 3 below.

Table 3

*Output of t-tests (comparing smartphone to handwriting production)*

	<i>T</i>	<i>df</i>	<i>p</i>	<i>d</i>
Participant 1	-2.11*	12	.05	-1.13
Participant 2	-4.38**	12	< .001	-2.34

\* denotes significance at the  $p < .05$  level

\*\* denotes significance at the  $p < .001$  level

The t-tests showed that there was a statistically significant decrease in the length of production on writing tasks when Participant #1 was using a smartphone compared to writing on paper: conditions;  $t(12)=-2.11, p=.05$ . Participant #2 showed a much larger decrease and degree of statistical significance when using smartphone compared to using paper: conditions;



$t(12)=-4.38, p<.001$ . Cohen's  $d$  was calculated to be  $d=1.13$  and  $2.34$ , respectfully, which would be considered "large" by current standards in L2 research (Plonsky & Oswald, 2014, p. 889)<sup>(13)</sup>.

## 5. Discussion

This empirical study, while limited in scope, clearly supports the literature that suggests that the medium chosen in which to conduct a writing task has significant implications for the students' end results, and that this extends to smartphones as well. This is highly significant for educational institutions to be aware of, due to the rise in prevalence of so-called m-learning (mobile learning) portal sites, which are seen as being the next evolution of e-learning (electronic learning), which was heretofore computer-based. As institutions considering making the switch to m-learning, it is highly recommended that they consider the results of this study and be aware that using smartphones for coursework may be more convenient in terms of time and place but appear to place more demands on the students cognitively that may negatively affect the quality of their work.

However, this study does not seek to claim that m-learning is not a viable method of delivery. A close inspection of the results in Table 1 shows that Participant #1 only wrote 11 words for Task 1, indicated perhaps that she did not understand the parameters of the task, or what was expected of her. While no guidance was given to the participants on purpose, to see what kind of work they would produce naturally, this does not mean that she was unable to produce more, as can be seen by her performance on subsequent tasks. While her natural inclination to produce only a short answer in response to a smartphone-based writing task is telling of her mindset (the next week she produced 108 words on paper, similarly with no specific guidelines), instructors could overcome this problem by simply setting minimum requirements when assigning writing tasks. This would guarantee a minimum response threshold, which could be determined by first observing the mean response of paper-based tasks. Also, the fact that she naturally began to produce more on her smartphone over time, suggests that extended exposure or practice with using a smartphone in this manner may also result in increased comfort or performance naturally, which at some point may match that of a paper-based assignment.

It also should be noted that this study only measured the differences in writing task performance. Previous research has suggested that students are generally supportive of using their smartphones for completing academic coursework (e.g., Almaiah & Jalil, 2014; Haag, 2011, Yaman, Şenel, & Yeşilel, 2015)<sup>(14)(15)(16)</sup> due to the multimedia benefits such a medium affords. In fact, there are attractive learning apps and games with sounds and graphics like Quizlet and Kahoot (Hulse, 2018)<sup>(17)</sup> that endeavor to make learning fun, although the empirical benefits of these apps have not been sufficiently documented. However, care should be taken when only considering the affective aspect of student engagement, which may lead to misconceptions about actual performance. Just because students may find m-learning emotively interesting and interactive does not mean that they will similarly engage cognitively to produce more on a writing task. To illustrate this point, precursor research (Lee, this issue)<sup>(18)</sup> surveyed  $N=225$  Japanese university students who have never used m-learning and found that 65.33% of respondents ( $n=147$ ) believed that they would write equally or more when using a smartphone, in contradiction to the results of this study. It is possible that students who imagine m-learning to be fun and exciting may sour to it when actually given the opportunity to use it in class.

## 6. Limitations and Further Research

This study comparing writing task performance on a smartphone compared to writing on paper was the first empirical study of its kind, at the time of this writing. As such, it has contributed significantly to the understanding of the differences between these two types of media. Due to the desire for obtaining data from proficient English learners who were majoring in English, it was necessary to recruit from outside of the researcher's home institution. Ideally, in the future it would be extremely beneficial to have a collaborator at a university which has an English major program to help facilitate with participant recruitment and meeting with participants for the weekly sessions. As this study only recruited two participants, data from a much larger sample would also be helpful to obtain more robust statistical results. Also, seeing as this was a

long-term study, spanning the duration of an entire academic semester, future research should investigate specifically the effects time had, if any, on performance (e.g., boredom or fatigue).

Finally, this study used the metric of word count to assess performance on the writing tasks, though this is not the only metric which could have been considered. Other metrics such as complexity, accuracy, or lexical variety could also be analyzed, as each of these factors could potentially be affected by the media the students are using to complete the tasks. As such, it would be necessary to design a different set of writing task prompts that perhaps included English for Academic Purposes (EAP) such as essay writing or critical response items. It is also possible that such prompts would affect the quantity/quality of prose written, as tasks with higher stakes may result in a higher level of cognitive engagement.

## 7. References

- (1) Plato. (c. 370 B.C.). *Phaedrus* [EPub]. Retrieved from [http://www.gutenberg.org/ebooks/1636.epub.images?session\\_id=723faa18883337783d2449c2a9d8e262a8cad15b](http://www.gutenberg.org/ebooks/1636.epub.images?session_id=723faa18883337783d2449c2a9d8e262a8cad15b)
- (2) Baron, D. (2009). *A better pencil: Readers, writers, and the digital revolution*. Oxford: Oxford University Press.
- (3) Japan Cabinet Office. (2014). *Mobile phone / smartphone penetration in Japan, 2014 March*. [Data file]. Retrieved from <http://nbakki.hatenablog.com/entry/2014/06/20/125616>
- (4) Pinet, S., Ziegler, J., & Alario, F. (2016). Typing is writing: Linguistic properties modulate typing execution. *Psychon Bull Rev*, 23, 1898-1906.
- (5) Sülzenbrück, S., Hegele, M., Rinkenauer, G., & Heuer, H. (2011). The death of handwriting: Secondary effects of frequent computer use on basic motor skills. *Journal of Motor Behavior*, 43(3), 247-251.
- (6) Mikulak, A. (2014). Getting it in writing: Writing the old-fashioned way may enhance learning and memory. *Observer*, 27(7).
- (7) Longcamp, M., Zerbato-Poudou, M., & Velay, J. (2005). The influence of writing practice on letter recognition in preschool children: A comparison between handwriting and typing. *Acta Psychologica*, 119, 67-79.
- (8) James, K.H., & Engelhardt, L. (2012). The effects of handwriting experience on functional brain development in pre-literate children. *Trends in Neuroscience and Education*, 1, 32-42.
- (9) Kiefer, M., Schuler, S., Mayer, C., Trumpp, N., Hille, K., & Sachse, S. (2015). Handwriting or typewriting? The influence of pen- or keyboard-based writing training on reading and writing performance in preschool children. *Advances in Cognitive Psychology*, 11(4), 136-146.
- (10) Longcamp, M., Boucard, C., Gilhodes, J., & Velay, J. (2006). Remembering the orientation of newly learned characters depends on the associated writing knowledge: A comparison between handwriting and typing. *Human Movement Science*, 25, 646-656.
- (11) Mueller, P.A. & Oppenheimer, D.M. (2014). The pen is mightier than the keyboard: Advantages of longhand over laptop note taking. *Psychological Science*, 25(6), 1159-1168.
- (12) Connelly, V., Gee, D., & Walsh, E. (2007). A comparison of keyboarded and handwritten composition and the relationship with transcription speed. *British Journal of Educational Psychology*, 77, 479-492.
- (13) Plonsky, L. & Oswald, F. (2014). How big is "big"? Interpreting effect sizes in L2 research. *Language Learning*, 64(4), 878-912.
- (14) Almaiah, M. A. & Jalil, M. A. (2014). Investigating students' perceptions on mobile learning services. *iJIM*, 8(4), 31-36.
- (15) Haag, J. (2011). From elearning to mlearning: The effectiveness of mobile course delivery. *The Interservice/Industry Training, Stimulation & Education Conference (I/ITSEC), 2011*(1). National Training Systems Association.
- (16) Yaman, I., Şenel, M., & Yeşilel, D. (2015). Exploring the extent to which ELT students utilise smartphones for language learning purposes. *South African Journal of Education*, 35(4), 1-9.
- (17) Hulse, R. (2018). The use of smartphones as an educational tool in the EFL classroom. *The Centre for the Study of English Language Teaching Journal*, 6, 93-138.
- (18) Lee, B. (2019). Japanese tertiary students' access to smartphones and their feelings regarding their use in the EFL classroom. *福井工業大学研究紀要 Memoirs of Fukui University of Technology*, 49, (in press).

## Appendix

The following are writing tasks as assigned chronologically. The medium of response is designated in the title as either “SP” (smartphone-based) or “P” (paper-based).

**#1-SP:** Welcome to this course. Please share your “language learning history”. (Please include details like: how long you have been studying English, if you have taken any lessons outside of school, if you have done study abroad before, etc.)

**#2-P:** Did you have a nice time over summer? Please tell me about how you spent your summer vacation!

**#3-SP:** Are you encouraged, or discouraged about learning English right now? Please explain why you feel that way.

**#4-P:** What are some activities that have really helped you in learning English? What did you do, and why do you think they were helpful to you?

**#5-SP:** Happy Thanksgiving! Thanksgiving is an American holiday, on the 4<sup>th</sup> Thursday of November. On this day, we think about the things that we are thankful for. What are you thankful for, and why?

**#6-P:** What are some activities that you think are NOT helpful for learning English? Why do you think so?

**#7-SP:** Winter is coming! What kinds of activities do you do in winter? (For example, do you play winter sports? Or do you take a trip? What is your family tradition for New Year’s, etc.) Do you have an annual routine? Please tell me about it!

**#8-P:** Do you have any non-Japanese friends? Have you made any foreign friends in school, or in other activities? Have you ever spoken to your Japanese friends, in English? If so, why? If not, why not? Please tell me how you use English outside of class or homework activities.

**#9-SP:** Happy New Year! What kind of year do you think 2019 will be? Please tell me your New Year’s Resolutions! Please tell me what you want to do, and why you want to do that. Don’t forget that you can make more than one resolution!

**#10-P:** Merry Christmas! What do you want for Christmas this year? Please write a letter to Santa and ask him for what you want, and why you want it! Don’t forget that you can ask for more than one thing!

**#11-SP:** Language and identity are closely linked. Can you think of any ways or any times that your personality is different when you speak English or Japanese? Please tell me about your ideas!

**#12-P:** Why did you enter university? Some people quit school and start working after high school; why did you choose to enter university? Please tell me some of your motivations.

**#13-SP:** What do you think your life will be like in 10 years? Tell me about your dreams for the future!

**#14-P:** How do you measure success? Everybody says that they “want to improve their English”. But everyone has different goals. What are your specific goals? How will you measure your success at meeting your goals?

(2019 年 4 月 26 日受理)