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Effect on keyboard-based English word acquisition

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ABSTRACT

Recent years, dramatic changes in the mode of writing have occurred. Computers and other digital devices are increasingly replacing writing by hand. The sensory-motor experiences of typing (e.g. visual, haptic, motor) are different from those used in handwriting. Therefore, the influence and effect of keyboarding on linguistic performance, compared to handwriting or letter tiles, has seen much inquiry. The results of these studies have been mixed. In this study, researchers used grounded theory to explore the experiences and perceptions of keyboard-based English word acquisition learners. The participants came from various ages and backgrounds (30 English training institute kids, 46 elementary school students, 7 college students, 14 in-service teachers), as well as 10 parents of lower age learners ($N=107$). Audio of the interviews was recorded digitally, transcribed verbatim and imported into NVivo 11.0 for coding and analysis. Overall, the participants confirmed the effect of keyboarding on English word learning, and a majority expressed positive attitudes towards keyboarding. Participants also listed which aspects of keyboarding interested them, such as improved learning efficiency, engaging learning activities or other incidental benefits.

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Introduction

In the twenty-first century's foreign language (L2) classroom, vocabulary is still being taught mainly through listening, speaking and writing activities (Macedonia, 2014). This is due to the long-established philosophy that language acquisition is considered to be an abstract phenomenon of the mind. However, many researchers (Kiefer & Barsalou, 2011; Kiefer & Pulvermüller, 2012; Kiefer & Trumpp, 2012; Mangen & Velay, 2010; Pulvermüller, 2005) began to believe that learning a new language should involve learners' kinesthetic intelligence, which could be referred to as "embodied learning", to improve learning efficiency and effectiveness (Palaigeorgiou, G., Foteini, P., Fereniki, T., & George, K. (2017).

Central to this shift in focus of second language (L2) learning is the question whether or not cognition is essentially grounded in our senses and depended on our interactions among body, mind and the environment (Kiefer & Trumpp, 2012). Traditional cognitivism assumes that cognitive processes are a function of the brain that deals with abstract-symbolic code, and the neuro-cognitive systems involved in cognition are substantially different from the perceptual or motor brains systems. Theories of "embodied cognition", which obtain increasingly more empirical support from neuro-scientific and psychological studies (Kiefer & Barsalou, 2011; Kiefer & Pulvermüller, 2012), propose that perception and action are not only closely connected, but indeed also reciprocally dependent (Mangen & Velay, 2010).

The brain modules that control language and action were believed to be independent for a long time, yet newly discovered evidence from neuroscientific studies reveals that language learning is likely an experience-dependent process (Pulvermüller, 2005). When we recall acquired words that are associated with a specific event, we reactivate stored sensory–motor experiences collected in the learning environment along with abstract-symbolic verbal knowledge (Engelkamp & Zimmer, 1994). According to Engelkamp, Seiler, and Zimmer (2004), participants achieved better in recall tests of a list of action verbs when they were asked to perform the corresponding actions during learning episode than merely heard or read the words. Another experiment demonstrated that participants who watched others performing the action also increase memory in comparison with those who just read the words, but not as good as those who self-performed the actions (Kiefer & Trumpp, 2012). Hence, the memorization and retrieval of language seems to benefit most from the direct sensory–motor experience during learning. The effect of gestures and body actions on memory for words and phrases in L2, as demonstrated in a variety of studies (Macedonia, 2014; Porter, 2012; Quinn-Allen, 1995; Tellier, 2008), is robust and well documented.

Embodied cognition theories emphasize the importance of perceptual experiences and sensory–motor interactions with the physical environment (Smith & Gasser, 2005). If “cognition is the internalization of externalized action in the environment” (Wartella, Richert, & Robb, 2010, p. 123), it is reasonable to argue that writing, as a basic manual sensory–motor skill, has direct influences on the way by which knowledge is acquired (Hove, Vanderhoven, & Cornillie, 2017). During the past years, dramatic changes in the mode of writing occurred. Digital writing devices such as computers, tablet PCs, or mobile phones are increasingly replacing handwriting (Kiefer et al., 2015). The sensory–motor experiences during typing (e.g. haptic, motor, visual) are different from those during handwriting. Hence, the influence of modality change in writing habits, namely handwriting versus keyboarding, on linguistic performance has been repeatedly investigated from a varied perspective.

A number of experiments (Longcamp et al., 2008; Longcamp, Boucard, Gilhodes, & Velay, 2006; Sturm, 2006) indicate that handwriting movements play a critical role in language learning, particularly in the visual recognition of letter or character shape. Cunningham and Stanovich (1990) reported that subjects performed better in word spelling if they were written out by hand than when they were typed or formed by arranging letter tiles. The study (Cunningham & Stanovich, 1990) was repeated by Kiefer et al. (2015) in preschoolers, and showed that the handwriting group achieved better word reading and writing performances than the group who typed the letters. This observation is supported by another experiment conducted by Longcamp, Zerbato-Poudou, and Velay (2005), the results of which demonstrated that even 4-year-old preschoolers memorized significantly more letters when they transcribed the letters compared to when they typed them.

On the other hand, typing, which involves extra psychomotor steps, results into an improved linguistic performance as demonstrated by several studies. Gascoigne (2000, 2006a, 2006b) found that typing, rather than handwriting, strengthens the application of diacritics in a series of studies involving French and Spanish learning in college students. Rogers and Case-Smith (2002) examined the relationships between sixth-grade students’ handwriting speed and legibility and their keyboarding speed and error rate. The results implied that keyboarding has the potential to increase and improve students’ written output. Calhoun (1985) explored the usefulness of typing, in contrast to handwriting, in a language art program for moderately retarded students and found that students performed better in speed and accuracy in written production by keyboarding than by handwriting.

Yet other studies found no significant differences between handwriting and keyboarding in language learning. Vaughn, Schumm, and Gordon (1992) replicated the study of Cunningham and Stanovich (1990) in LD (learning disabled) and NLD (Normal Language Development) elementary students, but did not find the superiority of handwriting observed by Cunningham and Stanovich (1990) in their investigation with both LD and NLD subjects. Sturm (2006) replicated Gascoigne’s (2000) experiment, and the result was no significant differences between handwriting and typing groups. Hove et al. (2017) compared memorization, spelling and use of diacritics of French vocabulary

with typing, writing and completing multiple choice exercise on tablets. The conclusion was “practicing vocabulary through handwriting and typing did not differ significantly from one another”.

The conflicting results of these studies can be due to the great variance in subject (age, SES, LD/NLD) and linguistic focus (letter, vocabulary, diacritics, writing), yet the limitations in some experiments cannot be omitted after a careful evaluation of these studies. A typical procedure of these studies was having participants practice a certain linguistic aspect (e.g. word, letter or accent mark) in keyboarding or handwriting conditions once or several times, followed by the administered tests, compared results and drew the conclusions. They were therefore either of limited duration (Cunningham & Stanovich, 1990; Gascoigne, 2000, 2006a, 2006b; Vaughn et al., 1992) or small in sample size (Calhoun, 1985), and some featured both characteristics (Longcamp et al., 2005; Sturm, 2006). Furthermore, with the relatively short training program and a few trial episodes, the scope and depth of the target language material were limited. Another point to consider is the influence of levels of subjects’ typing ability. The insufficient typing ability, usually related to the lower age kid, may affect the results of learning effect (Cunningham & Stanovich, 1990; Kiefer et al., 2015; Longcamp et al., 2005). Finally, there are few studies that examined the effect of language learning by keyboarding after a longer period of typing training, which could establish enduring sensory-motor experiences associated with typing. Development of cognition, and linguistic capacity in particular, takes time and needs to be examined from a broader range, which indicates that there are still a lot more to explore on this topic. It might not be able to sufficiently assess the effect of keyboarding in language learning without considering more comprehensive information about language learners’ experiences and perceptions. To this end, we adopted a qualitative approach to explore an in-depth understanding of different subjective response to the application of keyboarding in language learning.

The purpose of this study was to qualitatively investigate the effect of keyboarding in English words learning among learners with various age, background (from preschoolers in language training institute to in-service teacher trainees) and duration involved in keyboarding learning (from about three months to more than two years). Besides, a number of parents of learners were also included in the study. This study aimed to answer the following questions: (1) Does the application of computer and keyboard constitute an advantageous condition for English word acquisition? (2) If the application of computer and keyboard constitutes an advantageous condition for English word acquisition, which characteristics of keyboarding lead to the improved learning efficacy?

Methods

Design

The researchers used grounded theory to methodically obtain and analyze data, develop a conceptual framework, and then answer the research questions (Charmaz, 2006; Strauss & Corbin, 1998). In the present study, data were collected through in-depth interviews with theory being produced inductively from the data.

Participants

The participants were recruited from each of the groups who joined in the keyboarding-in-English-Learning experiments, which include an English training institute ($N = 30$), as shown in Figure 1, three elementary schools ($N = 46$), as shown in Figure 2 and a college class ($N = 7$). This population of participants was selected as such to ensure a maximum variation on the basis of combined characteristics of the length of time they had enrolled in the experiments and their English performances. Owing to the small size of the teacher training program, we included almost all the participants of the program ($N = 14$) as well as a small number of parent participants ($N = 10$) from the training institute, which were randomly selected (Table 1).



Figure 1. Kids learning English in the English training institute.



Figure 2. Students learning English in an elementary school.

Table 1. Participants demographics ($N = 107$).

Subject	Number	Gender		Experiment duration			English performance		
		Male	Female	Less than 6 months	6–12 months	More than 12 months	Inadequate	Median	Good
Training institute kids	30 (K1–K30)	17	13	5	8	17	11	10	9
Elementary school students	46 (S1–S46)	21	25	8		38	20	16	14
College students	7 (C1–C7)	3	4		7		2	2	3
In-service teachers	14 (T1–T14)	5	9	14			n/a	n/a	n/a
Parents	10 (P1–P10)	3	7	1	3	6	n/a	n/a	n/a

Procedure

First, the keyboard-based word learning instructions were evaluated in an English training institute, three elementary schools, one college class and an in-service teacher training program over the past three years. A patented Windows keyboarding application that was designed to help learners to learn English vocabulary was used in the study. Although the experiment was conducted in learning institutions of various nature, the keyboarding application, learning process and teachers who organized activities were kept as similar as possible to ensure the reliability of the study data. Then, interviews were conducted by the research team. Finally, researchers analyzed the data using grounded theory and generated conclusions.

Interview protocol

The interviews were conducted using a semi-structured interview guide by either the principal investigator or a research assistant. The interviews typically lasted for approximately 15–25 min. All interviews were conducted face-to-face in a classroom or a private office, audio recorded and transcribed verbatim.

Semi-structural interview guide

The overarching goal of the interview was to acquire learners' perception of the effect and efficacy of keyboarding in English word learning and how are their interests in and attitudes towards the keyboarding in English learning. The interview guide was developed by the research team.

Q1: How long have you been learning English?

Q2: Do you like keyboarding for English words learning? Describe the reason.

Q3: Do you think keyboarding help you to learn English words better? If yes, describe the reason.

Q4: How did you use to learn English words? And which way do you prefer to learn English words between keyboarding and other methods?

Q5: Would you like to continue to use keyboarding to learn English words in the future?

Q6: Do you have any additional comments to share?

Data analysis

107 verified interview transcripts were imported into NVivo 11 qualitative software (QSR International Pty Ltd; Victoria, Austria; version 11.2) for coding and analysis. The research team was composed of one principal investigator and four research assistants. One research assistant developed an initial coding scheme based on the first transcript. Then, the research team held two rounds of discussions on the coding scheme. During the process of discussion, all four research assistants kept testing against data using the initial coding scheme based on which revisions were recommended. The final coding scheme was decided upon after two rounds of discussions and provided the primary components of our preliminary conceptual framework. The research team pooled the data together and constantly compared them to identify major and minor themes. New data were repeatedly compared to the previously categorized thematic frame with attention paid to variations.

Results

Thirty training institute kids, forty-six elementary school students, seven college students, fourteen in-service teachers and ten parents participated in this study. Our analysis revealed four broad categories of themes that summarized the experiences and perceptions of language learners who

Table 2. Learners' and parents' perceptions of keyboarding in English words acquisition.

	The effect of keyboarding	N
Time spent	• It takes Learners less time to memorize English words by keyboarding (K:18, S:22, P: 8)	48
Firmness	• Learners remember English words deeply (K:7, S:16, C:3, T:2, P:2)	30
Pronunciation	• Learners acquire better knowledge of pronunciation of English words (K:3, S:1, T:2)	6
	• Learners improve their listening comprehension with refined pronunciation (K:1, S:2, T:1)	4
Academic performance	• Learners Improve their English academic performances as a result of better word acquisition (K:3, S:9, P: 1)	13
Unsatisfactory effect	• Learners have difficulty in learning words by keyboarding because their typing is not skillful enough (S:7, C:2, T:4)	13
<i>Learners' interests in using keyboard</i>		
Efficiency	• To keyboard a word is faster than to read or write one, learners can achieve more repetition by keyboarding in a given time, thus obtain better learning results (K:7, S:16, C:3, T:2, P: 2)	30
Delight	• Learns enjoy the process of learning and practicing English words by typing, which is somewhat like playing a game (K:3 S:6)	9
	• Learners can compete with others as well as themselves in the speed and accuracy of typing (K:5, S:2, P:7)	14
Motivation	• The skillful typing ability makes learners more confident for mastering a skill their peers does not have (K:6, S:4, P:3)	13
Facilitation for other learning	• The skillful typing ability facilitate learners' learning in IT related curricula (S:2, P:7)	9
<i>Learners' attitudes towards keyboarding</i>		
Compared with other word learning method	• Participants who prefer keyboarding (K:12, S:37, C:3, T:1, P: 4)	57
	• Participants who prefer another method (K:5, S:8, T:5)	18
	• Participants who have no preference (T:7)	7
Willingness to continue to use keyboarding	• Participants who would like to continue to use keyboarding to learn English words (K:21, S:41, C:2, T:9, P: 4)	77
	• Participants who will not continue to use keyboarding to learn English words (C:1, T:4, P: 1)	6
	• Participants who, regardless of their choice in continuance, would like to recommend keyboarding to others (T:13)	13
	• Participants has not made up their minds (S:2, C:4, P:5)	11
<i>"Embodied" proof of keyboarding</i>		
Typing in the air while remember English words	• Participants who were asked the question and reported the occurrence (K: 10 asked 10 reported; S: 46 asked, 36 reported; C: 7 asked, 4 reported; P: 10 asked, 2 reported)	52

Note: K: English training institute Kids; S: elementary school students, C: college students; T: in-service teachers, P: parents of lower age learners.

acquire English words by keyboarding. These included the effect of keyboarding on English words learning, the learners' interests in using the keyboard to learn English words, the learners' attitudes towards keyboarding and the "embodied" proof of keyboarding in learning English words. They are described in detail below and outlined in Table 2.

The effect of keyboarding

Most participants evaluated the effect of keyboarding positively; they believed that the keyboarding application resulted in an improved learning effect for English word acquisition. During the learning process, the meaning of an English word popped up on the computer screen and pronunciation was heard simultaneously through a headphone while a learner typed a word. The word would not disappear until the learner made correct keystrokes. The combined visual, aural and kinesthetic stimuli are believed to contribute to the enhanced learning effect.

Time spent and firmness

Some participants felt that they memorized English words faster by keyboarding. They compared the different learning processes between keyboarding and the traditional approach such as reading or

writing. They used to focus on one aspect of words at a time, such as firstly paid attention to the spelling, then focused on meaning, and lastly mastered pronunciation. However, with the keyboarding application, learners received multiple stimuli of English word information and had to respond to all at once with the correct keystrokes, which increased the pace of acquiring English words for some participants.

For other participants, the combined stimuli during keyboarding may not necessarily make them memorize English words faster, but more firmly instead.

I think I like the keyboarding, it makes me learn ... much faster than before ... mmm ... it's a little hard at the beginning though. (K-12)

I feel I learned the words faster with keyboarding, because when I typed the words, I knew the meaning at the same time, so I could remember them deeply. (K-29)

I found that the method is amazing, never saw it anywhere else ... my daughter memorized the words faster with this method ... she didn't need to spend extra time to go over the English words after English class. She performed quite well in English tests. (P01)

"The keyboarding ... I recited the words firstly, and then typed it, I felt I remembered them deeply. (C06)"

Pronunciation

A good command of pronunciation is key to the mastering of English, and many participants confirmed that this was a weak link in their knowledge of English language. With the pronunciation information presented every time a learner typed a word, a number of participants reported that progress had been made in their pronunciation since they began to acquire English words by typing. Among them some participants reported that they paid more attention to pronunciation than before and could hear the words and sentences more clearly in English classes.

Typing is much better than handwriting, we used to handwrite English words, and I didn't spell it out loud while writing, now I spelt it out loud while typing, the sound of words got into my ear ... then I remembered them. (K15)

There were pronunciation of words when I was typing, it really helped me remember the pronunciation. (C05)

It helped my learning, especially when I did the dictation tests, I can hear the words more clearly than before. (S29)

I like the typing method, it corrected a lot of my pronunciation. The sound is a good stimulus ... for learning. (T04)

Academic performance

A few participants also reported improved test scores in English examinations. Knowledge of words is the foundation of English language ability and affects reading, writing and listening comprehension. As a result, it might not be surprising that some participants achieved better test results.

I have been learning English words by keyboarding for two years, I like the approach so much ... I made big progress ... and now, I often list top of the class in English examinations. (K24)

I felt the keyboarding helped my English very much, my English test scores used to be around 80, now my English test scores are usually around 90. (S10)

I feel the keyboarding is effective, my English was not good before I learned keyboarding, now my test scores improved a lot. (S18)

Unsatisfactory learning effect

A few participants are disappointed at the keyboarding approach. They said that their typing is not skillful enough, which made it difficult for them to finish the learning task.

I prefer to learn the English words by handwriting ... I'm not familiar with the keyboard, so I felt typing was burdensome. (S-41)

Typing is a little difficult, that's the biggest problem I encounter in the learning. (T-08)

Learners' interests in using keyboarding

Efficiency

Word acquisition in a foreign language is a demanding task. To overcome this issue, learners usually resort to practice repeatedly by reading, writing or other means. Some participants emphasized that the practice efficiency of keyboarding was what interested them. They explained that they used to memorize English words through repeatedly reading or writing them, which indeed became boring after a while. Now, to type a word is much faster than to read or write one. So they can finish the learning task by keyboarding in a shorter period of time than they used to using the reading or writing approach. In other words, more repetition of practice achieved by keyboarding resulted in an improved learning effect.

I like keyboarding ... because it's fast ... type fast, remember fast. Once I was typing with a girl sit next to me, she just sit there typing, she told me that she didn't like the handwriting way, writing and writing drove her crazy. (K-17)

Typing is better than handwriting, because you'll easily get tired with handwriting, then you'll get bored. For typing, it takes a little time to type a word 10 times, and I don't feel my hand tired. (K-15)

I pretty like keyboarding ... my parents used to have me memorize English words by transcribing, I hate it ... I find typing is easy, and I can remember the words better, so I like it handwriting is irritating (K-18)

Delight

Some participants, especially those who are younger, mentioned that they were intrigued by the game-like learning mode of keyboarding. The application is designed to present the words for learning or practicing by groups, five or ten words per group. Participants were not able to proceed to the next group of words until they finished the current group. The design is somewhat like the levels in computer games. A few participants endorsed the timing function that reminded learners how much time it took for them to finish a particular group of words. They reported that they enjoyed competing with other learners or with themselves, which prompted them to strive to type faster.

I like typing, we three ... are competing to see who can type the fastest. I will try and beat them. (K-10)

Learning by typing is pretty interesting ... I used to learn by reading word books (C-01)

She (my daughter) felt a sense of accomplishment after she finished a group of words, she is a diligent girl ... she typed fast and she got good grades, so she felt a sense of accomplishment ... she often told me after classes that how many groups (of words) she had finished that day, she told me that only she and so-and-so were the best in her class ... I can see the smile on her face. (P-04)

(Do you like typing?) I do ... (Why do you like typing?) Because I can feel the pleasure when I am typing ... (What kind of pleasure?) The pleasure of learning English ... (K-28)

Motivation and facilitation for other learning

The skill of typing is the basis of keyboarding. Most learners improved their keyboarding abilities after a period of practicing, which made a number of participants feel more self-assured. They were proud of possessing skillful keyboarding abilities that their peers did not have. Some participants explained that because of that they were motivated to improve their keyboarding skills. Apart from the typing skill itself, some participants of elementary school age or their parents reported that skillful typing did keep them ahead of others in the IT curriculum in the schools.

The keyboarding is interesting ... sometimes I would like to show off my typing skill to my classmates, I can type fast, and they cannot. (K-21)

I like typing this way! I can beat others! I am the fastest typist in my school, and beat 74% people the whole country in typing. (K-27)

I felt it helped me a lot in IT curriculum, because IT curriculum asked us to type. (S-04)

I think he (my son) likes keyboarding, he typed very fast in IT class in the school, so the IT curriculum seemed effortless for him. (P-05)

He (my son) had to sign up for a course related to IT at grade three, and he told me, with the skillful typing, he always felt at ease in searching information or programming ... His head teacher even made him his assistant because he typed fast. (P-06)

Learners' attitudes towards keyboarding

Participants were asked what kind of approach they preferred to learn English words after they have experienced keyboarding. 55 participants (51%) answered that they preferred keyboarding; 18 participants (17%) answered that they preferred the approach they used to adopt; 7 participants (6%) answered that they had no preference; and 27 participants (26%) did not answer the question. When they were asked about their willingness to continue to use keyboarding to learn English words, 77 participants (72%) said that they were willing to keep learning English by keyboarding; 6 participants (5%) showed no further interest in keyboarding; 11 participants (10%) had not made up their minds; and 13 participants (12%) did not answer the question. Interestingly, 13 participants, all of which were in-service teachers, would like to recommend keyboarding to others regardless if they intend to continue to learn by keyboarding or not.

My father used to have me read and dictate English words ... I don't like these methods ... I prefer this way (keyboarding). (S-15)

I think I would like to keep learning words by keyboarding ... There were a lot words I was able to pronounce but not sure about the spelling, for example, the word "donut", after the typing training, I knew how to spell them correctly. (C-07)

I won't continue to use keyboarding ... I'm not young and my fingers are not dexterous enough ... however, I think learning by typing is a good approach ... I would like to recommend it to my students or my relations if I got the chance. (T-13)

"Embodied" proof of keyboarding

One participant mentioned that sometimes he would tap his fingers on the air, which is obviously an unconscious typing action, when he tried to remember or spell an English word. We found it interesting and then added the question in the following interviews asking participants whether they had the similar experiences. 100% of the institute kids reported that such tapping action occurred to them (10 kids were asked the question); 81% elementary students reported the tapping action (36 elementary students were asked the question); 57% college students reported the tapping action (all the 7 college students were asked the question); 20% parents also reported that they observed the actions happened to their children (all 10 parents were asked the question).

Discussion

This study, to the best of our knowledge, is the first in-depth qualitative assessment of the effect of keyboarding on English word acquisition. Researchers found that learners' experiences and perceptions offered a rich context for identifying the factors and processes that constitute the English language learning by keyboarding.

The effect of keyboarding on English word acquisition was demonstrated by our findings that a majority of participants confirmed the effect in various aspects, such as less time spent on the learning process, firmer learning results, improved academic performances as well as refined pronunciation. We found, from an embodied cognition perspective, that the effect of keyboarding can be largely attributed to the quality of sensory-motor experience in typing (haptic, motor, visual). According to Cohen and Wickland (1990), typing can be largely accounted for by three component abilities: spelling, memory for the keyboard, and the motor skill, which is more complicated than handwriting or reading. The interaction between action and perception during typing, which establishes rich sensory-motor traces, could facilitate English word acquisition.

The improved learning effect was most significant among training institute kids and elementary school students, almost all the kids confirmed the effects. A few elementary school and college participants reported unsatisfactory results, and two-thirds of the in-service teachers were not enthusiastic about learning English by keyboarding. The analysis of the data identified unskillful typing capacity as the cause of unsatisfied learning effect. The finding found support from previous studies. In the experiments that did not indicate the superiority of keyboarding (Cunningham & Stanovich, 1990; Kiefer et al., 2015; Longcamp et al., 2005), typing typically involved with single key-strokes by participants who had not yet learned how to type (Sturm, 2006), while the experiments that demonstrated the superiority of keyboarding (Gascoigne, 2000, 2006a, 2006b; Rogers & Case-Smith, 2002) required participants to type using all fingers. The discrepant typing approach, which in essence involves different psychomotor steps, directly affected the learning result.

Our findings suggest that the advantage of keyboarding in English word acquisition included higher learning efficiency, game-like learning mode, motivation from acquired typing skills and facilitation for IT-related course learning. There was a positive correlation between the time involved in the keyboarding experiment and learning efficiency. It can be inferred from Kiefer et al. (2015) that superiority of keyboarding performance can only be obtained when typing training is sufficient to establish enduring sensory-motor memory trace. The game-like learning mode of keyboarding, which featured progressive levels of difficulty as well as a competitive learning environment, typically illustrated the benefits that technologies can offer to the language learning: The integration of technologies into the classroom assists to engage learners in the task, and stimulates learners to participate in the learning activities (Billings & Mathison, 2011). The proficient typing skill, as a result of adequate keyboard training, became a source of self-assurance and facilitated some younger participants' IT curriculum. This in return contributed further to their enhanced learning experience and positive attitude.

The percentage of positive attitudes towards keyboarding is consistent with that of the overall positive effect. A majority of participants preferred the keyboarding approach and intended to keep learning English by keyboarding. Participants who preferred another approach and had no intention to keep learning were still discouraged by their inadequate typing skills. Most of them are in-service teachers apart from several elementary and college students. The teachers' less proficient typing skills were due in part to the short duration of the program that caused insufficient training. Furthermore, the nature of the training program also played a role. It is not demanding and without specific obligation, the principal purpose of the teacher trainees for the program was to get the credits required by the local board of education. The teachers' weak motivation resulted in a lower performance compared to other participants; hence, their less positive effects and attitudes.

We found that while trying to recall the learned words, some participants would unconsciously perform the typing action in the air. This is in line with what Naka and Naoi (1995) reported. Japanese adults often reported that they wrote with their fingers in the air to identify complex characters. If the finger writing movement was suggested as a proof that learning by writing facilitated subjects' memorization of graphic forms (Naka & Naoi, 1995), the finger tapping action could also be perceived as a proof that learning by keyboarding facilitated the memorization of English words. According to Kiefer and Trumpp (2012), cognition and thinking, which is essentially ground in our perceptual and motor

system, is to a large extent the reproduction and simulation of previous experience through bodily actions. The finger tapping action reported and observed by the participants of this study suggested that the action representation established during the word learning process was reactivated and facilitated memory retrieval.

Conclusion

Modes of writing are at the core of human learning. They have a profound influence on learners' cognitive and language development (Mangen & Velay, 2010). The present study explores learners' perceptions and experiences on the effect of keyboarding on English word acquisition. It also identifies the factors and processes that constitute English word learning by keyboarding. While its findings enhance understanding of this topic, this study does have its limitations. Thus, future research is needed in this field.

Firstly, the interpretation of the results was limited by the qualitative method employed in this research; all data collected were self-reported by the participants and lacked data triangulation. It should be of interest to future researchers to quantitatively assess the positive effects of keyboarding in English word acquisition, such as the lesser time investment, and the improved word acquisition and academic performance, so as to verify the findings of this study. Secondly, this research covers institute kids, elementary school students, college students and in-service teachers of varying ages. Yet, the unequal number of participants per group presents a limitation that should be noted. The variance in the numbers of participants in different sample groups may have diminished the validity of the research results. Thirdly, the findings demonstrate that younger learners benefit from the keyboarding approach in English learning. Due to the fact that younger learners' learning programs are more demanding and last longer than those in which adult learners participate, this possibly lead to better typing skills and more interest in learning, which improves effects and attitudes. It remains unclear whether the keyboarding approach is more age-appropriate for younger learners, or if the different nature of learning programs cause the variation in effects and attitudes among different participants. Therefore, the age effects on language learning by keyboarding remain to be addressed in future studies. Finally, whereas the findings of this study recognize the possible benefits of computer and keyboarding application in English word learning, they do not suggest replacing the pen with the keyboard in foreign language classroom. Handwriting involves different motor program than keyboarding; the action-perception coupling during handwriting facilitates language acquisition and associates graphic shapes of letters with specific hand movement (Kiefer et al., 2015; Mangen & Velay, 2010), which does not exist in typing. Therefore, the letters or characters learned through keyboarding may subsequently be recognized less accurately than those learned by handwriting.

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