The Establishment and Evaluation of a Multi-Learning System to Assist the Congenitally Blind to Use the Boshiamy Method to Input Chinese Characters

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ABSTRACT

By using a sound-decoded input method like Zhu Yin, the congenitally blind are able to input Chinese characters into a computer which allows them to type and access needed information. However, they experience great difficulty selecting the correct same-sounding characters and words from others. Consequently, their overall learning and, oftentimes, career development, suffers as a result of frequent typos which makes them even more socially vulnerable. For this study, a multi-part learning system consisting of instructional materials, three face-to-face taught instructional courses, assistive learning technologies such as NVDA, and a typing performance assessment, is established. Six subjects, three adults and three children, were chosen to participate in this experimental study. During the course of the study, each subject was assisted by a sighted individual who verbally described to the subject the components of Chinese characters. The dependent variables examined were the number of typos typed, typing accuracy, and the speed at which the subjects were able to input the characters. The study also included semi-structured interviews and scenery observation. The preliminary results of the study revealed that the adults experienced limited progression due primarily to problems adapting to the system whereas, conversely, the accuracy rate and typing confidence of the group of children was significantly enhanced.

Keywords: Chinese character learning, Chinese input method, Congenital blindness

1. INTRODUCTION AND MOTIVATION

Learned as a tool, Braille opens a means by which the blind can access language. In English, the different arrangement of Braille dots directly corresponds to the letters of the alphabet which are, in turn, mapped to the keys on the keyboard (Li, 2011). Using Braille, the blind are able to learn how to spell and understand words through touch similar to how the sighted learn words using vision. This method of learning has been of great benefit to the blind for centuries, and has been adapted for use in other languages as well, however, in China, Japan, and Taiwan, Braille is composed of vowels and consonants that only represent the sound of the characters, but not the individual Chinese character structures themselves (Murata, 2004). The problem then arises that many different characters with the same or very similar sounds have an identical combination of Braille dots. Not only does this obstacle confuse blind persons who natively speak and need to type these Asian languages, but it also serves to make them partly illiterate as well.

Computer literacy is a vital aspect of providing people with E-communication skills for advancement in their careers and in gaining a competitive edge in the workforce (Wong and Tsang, 2007). With the advent of personal computers

and the Internet, typing has become the most common method of input to access information and operate a PC (MIC ITIS, 1999; Wang, 2007). It is for this reason that an effective method of input for the blind to type is a necessity and, as such, a basic ability required for digital learning and interaction over the Internet.

In Taiwan, the majority of the congenitally blind are taught to type by Zhu Yin, which is a sound-based system. However, there are many characters that sound the same yet have very different meanings. As an example, there are a total of 207 characters containing the same sound "Yi" in the Mandarin Chinese language, but the characters have varying meanings. Because it is extremely difficult, if not nearly impossible, for the blind to tell the difference between same-sound characters using the Braille system, it is not uncommon for them to neglect the learning of such characters entirely (Chuang, 2004). The congenitally blind are often partially illiterate to begin with. The fact that there exists no effective method of computer input for them only serves to limit their career growth even further (Yang &Chen, 2011; Hsiao, 2012). Typing accuracy is directly related to job competitiveness, yet few studies have attempted to address this issue for Chinese people with congenital blindness.

2. OBJECTIVES

The purpose of this study is to develop a method of assisting the congenitally blind to learn the Boshiamy method of input. This is accomplished, in part, by teaching them the concept of the structure of Chinese characters. It also takes advantage of assistive learning technologies in order to break through the congenitally blinds' learning disabilities and limitations. The study's major goals are as follows:

i. That the subjects are able to reach the entry level Techficiency Quotient Certification (TQC), which equates to being able to type 15 characters per minute accurately.

ii. That the subjects are able to construct the concept of the basic components of Chinese characters, that being, in most cases, less than five strokes. Additionally, they are expected to understand the verbal description of Chinese characters.

iii. To improve the subject's confidence and typing accuracy.

iv. To help identify the difficulties and obstacles that the subjects' encounter during the course.

3. BACKGROUND

3.1 Chinese Characters Features

The Chinese language is one of the most unique and historic of all languages. The earliest record of this systematic category of language is "Shuowen Jiezi," a dictionary that first appeared during the Han Dynasty that explains the basic principles of forming Chinese characters (Hsiao, 2012). Shuowen Jiezi contains six models: pictograms, ideographic, compound ideographs, phono-semantic compounds, phonetic loan characters, and derivative cognates (Wikipedia, 2014). It points out that Chinese characters are made up of a combination of sounds, semantics, and forms that, when arranged together, form a character with a unique meaning. The characteristics of Chinese words and characters can be described as follows.

i. Characters are formed with components, the basic unit of Chinese structure. Some components can be seen as a single character, while others can be arranged differently to form a group of characters. (Ho, 2012).

ii. Each component has meaning, but the different combination of components may form a character and have different meanings.

iii. Same characters may have different sounds whereas different characters may have the same sound.

iv. Unlike other alphabetic languages that are written in one direction, the form of Chinese characters is multi-directional (i.e. from right to left, top to bottom, and/or outside to inside) (Ho, 2012)).

3.2 Chinese Character Instruction for the Congenitally Blind

For this study, we interviewed two congenitally blind individuals with the goal of gaining a greater understanding of their work environment and situation. Their response was that they were taught only to use the Zhu Yin method of input to input Chinese characters while typing. Also, they did not have confidence in their typing accuracy even though they had developed their own individual "intelligent term base" specific to their occupations. These results aligned closely with what Jiang (2004) said when he concluded that the current Chinese braille decoding system is ineffective in assisting the blind to type accurately, thus leading to great frustration in their overall learning, social communication, career development, and ability to access information.

Chinese is a pictogram language that implies visual messages, therefore, understanding the words' or characters' basic structure is imperative to learning Chinese (Kwok & Chan, 2008). Hsiao (2012) designed a study for teaching and evaluating a congenitally blind individual to learn 48 characters. He found that Tactile Chinese Character Instruction (ICCI) had an immediate and maintaining effect on improving the performance of character recognition for the subject. In order to help them learn to use the computer, scholars in Japan also focus on teaching congenitally blind Japanese students the same concepts behind Chinese character learning and writing. Nozomi & Umehara (1986) categorized the Chinese characters into 11 structure types. Sawada, Kagawa, and Chida (2003) believed that students must first learn the concept behind composing the different components of Chinese characters, and then use the tactile character material to construct character recognition.

3.3 The Chinese Input Method

Although there are many different ways of inputting characters into a computer (i.e. handwriting, speech to text (STT), and typing), due to its degree of accuracy and efficiency, only the typing method was considered for this study. The decoding system of keyboard input in Taiwan can be further categorized into either sounded-based (i.e. New Zhuyin, Tzu Ran, etc.) or structured-based (i.e. Cang Jie, Da Yi, Boshiamy, etc.) systems. According to a Pollstar survey conducted in 2011, more than 70% of Taiwanese use the Pin Yin system to input Chinese, 10.2% use the Boshiamy method, and 9.9% use the Cang Jie method. The primary reason Chinese people apply Zhu Yin to typing is because they were taught to use Zhu Yin to help them learn the Chinese language in elementary school.

Boshiamy was invented by Liu Chung-tz'u in 1989. It is comprised of about 300 Chinese radicals represented by 26 letters that are used to build Chinese characters. Radicals are mapped to letters by their forms, sounds, or meanings (Wikipedia, 2014). Our study utilizes the Boshiamy method because of the following characteristics thought most applicable to the congenitally blind:

i. Low frequency of character choice.

ii. Transforming rules, which is to say that several form-look-alike components can be viewed as falling within the same category. For example, "央" (meaning "central") and "史" (meaning "history") are based on the character "中" (meaning "mid"), and use the root "C" in the system (CN and CX). Due to Boshiamy's transforming rules, students don't necessarily have to memorize all of the individual strokes needed to create the character, rather, they only have to understand the core root of the character or the character's structure.

iii. Extendable term-base- these enable the user to set simple codes to represent certain phrases, for instance, "國立清華大學" (meaning "National Tsing Hua University") can be written as "NTHU," and the proper name, "翁登樺," (translated "Weng, Teng-Hua")" can be written as "WTH."

iv. Boshiamy's decoding system is designed to associate sound, form, and semantics, which enable the learner to memorize the characters' roots in a more intuitive way.

4. METHODS

The study's research framework is illustrated below in Fig. 1. We first prepared an in-depth interview to help us understand the obstacles faced by the congenitally blind Chinese typist. Next, we designed a ten-week course and prepared the teaching materials to assist them in learning the new method. As part of the course, the subjects were taught the rules of the Boshiamy input method as well as the basic concepts behind the components of Chinese

character structure. The subjects' typing performance was then accessed and the data collected. During the assessment phase, the subjects' reflections and responses to learning were used to adjust both the pace at which the content was taught as well as the content itself. Also, the subjects' sequential performance and subjective mental workload were analyzed as well. In addition, spot observations and field discussions were conducted during the course work also.

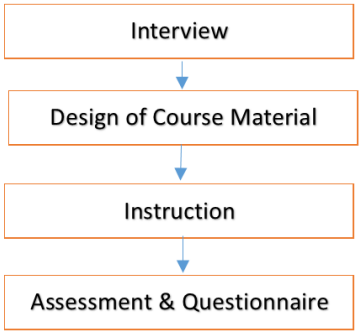

Fig.1 Research Framework

4.1 The Participants

Six subjects, three elementary students and three adults, were chosen to participate in the study. Due to the differences among the subjects, the individual conditions were introduced as follows:

Subjects A and B were in the first and second grades respectively in a "normal" elementary school. They had just begun to learn Chinese characters the same way as their sighted elementary school students' counterparts were learning them. Subject C was in elementary school fifth grade. Subject C was born with low vision (i.e. 0.03) but he was still able to recognize and learn characters with the help of a magnifying tools. Subject D was studying at university. Subject D had right ear impairment. Both subjects E and F had graduated from university and were employed as knowledge workers (i.e. a customer service employee and computer teacher). The adults in the study lacked the concept of Chinese component structures and could only compose their names and a few additional characters. All of the participants except subject D were legally blind without any additional mental or physical impairments.

4.2 Interview

For this part of the study, the researchers conducted four rudimentary pilot interviews for two of the subjects from July to October, 2013. This was done in order to confirm the validity of the interview design and to better understand the internal and external factors that influenced the subjects' responses. During the interview process, it was discovered that the physical environment in which the interviews were conducted had many distractions and was an important factor that negatively influenced the interviewees and their responses. For this reason, and in an effort to eliminate outside interferences and distractions as much as possible, from that point on, the interviews were conducted under more closed conditions.

The interview outline was used to remind the researchers of the study's key points and purpose. It contained several questions about their typing experience using the Likert five-level scale. The subjects were not required to complete all the questions completely but, rather, were allowed to freely express their thoughts about the questions. In that some of the subjects were too young to answer some of the questions personally, we interviewed both the subjects and their parents so that the parents could share their experience as supplemental reference. The main objective of the interviews was to understand the subjects' learning environment, and it was understood that the parents would play a major role in assisting the younger subjects.

4.3 The Design of the Course Material

The ten-week course included three face-to-face sessions as well as material for the subjects to study on their own. In order to be able to type correctly using this method of input, the congenitally blind subjects had to learn both Boshiamy as well as memorize the corresponding code of Chinese character structures. Thus, the instruction program focused on teaching the Bishiamy rules, Chinese character information, and the assistive mechanism.

i. The subjects had to learn the step-by-step rules associated with the Boshiamy method according to the following chapters:

   (a) Ch.1. Basic elements: Understand how to write numbers from one to ten in Chinese and 26 English alphabets which could be found in many Chinese characters.

   (b) Ch.2. Root taken sequence: Understand the sequence of root by using the character structure tactile material mentioned above. Take the character "明" (meaning "bright") for example- the left part is taken first; then the right.

   (c) Ch.3. Supplementary rules: Understand the 11 different types of shapes of the last stoke of the character.

   (d) Ch.4. Transforming rules: Understand the concept of transforming and association to the core root.

ii. Developing the concept of Chinese components (Ch.5):

   (a) Considering that it was their first time to learn the forming of characters, this study started with 300 of the most common characters used at the junior level of elementary school. The characters shown in the Chinese text book of the junior class are considered primary learning targets.

   (b) Tactile character material was designed. Each page included six 7cm x 7cm components, or characters, with a height of 0.5 mm according to the tactile study proposed by Edman (1992)).

   (c) The Chinese components teaching method was used. This method was used to teach the student how to combine known components with new ones.

   (d) Practice assignments were given to the subjects each week.

iii. The assistive mechanisms:

   (a) Each subject had an accompanier during his coursework. In many cases, the accompanier was the subject's own parents who verbally described the form of the Chinese character to the subject. The accompanier also played an important role in assisting the subject at home by collecting the performance data and relating the problems the subject experienced to the researchers.

   (b) With the exception of the tactile materials, other materials were transformed into electronic files that could be accessed by voice-reader tools as well as screen readers.

   (c) Distance-learning and problem-consulting were available through email and Skype throughout the duration of the study.

   (d) A Chinese character database containing 4,700 common character descriptions and their usage was offered to the students.

4.4 Instruction

The instruction was carried out in the National Library of Public Information where the equipment was located. A total of three courses were held on October 13th, November 10th and December 15th, 2013, respectively, for seven hours each day. During the courses, the researcher video taped the sessions and recorded the subjects' performance.

i. During the first course, the previous four chapters were covered. They were taught using the aforementioned materials so that the subjects would be able to fully understand the rules.

ii. The focus of the second course was primarily on teaching the Chinese component and giving explanation with association as well as detailed information.

iii. The focus of the final and third course was primarily on the reviewing and refreshing of the content taught in the first and second courses. Advanced usage functions such as brevity root coding and language shifting were explained during the final course as well.

4.5 Assessment

There are many examination-type software packages that provide typists with visual clues, but few that provide auditory clues. For this study, we required one that provided auditory clues. We opted to use IQ-Chinese Quiz, which is a listening-typing examination software that allows choice in both examination contents and reading speed. The parameters set for the examination were 5 minutes of examination time and 140 characters per minutes of reading speed allowing for pauses in-between each sentence. The typing accuracy and typing speed were examined. Before the formal instruction, the subject's ability to type using the original input method was assessed. This was done in order to create a control with which to compare the results obtained using the Boshiamy method. Each subject completed the assessment test a total of four times. They were asked to fill out questionnaire and interview individually as part of the final course.

5. RESULTS

5.1 Typing Performance

NOTE: It was decided that the sixth subject, subject F's, score be excluded from the final results section of this study. This was deemed necessary in that the subject did not properly follow the instructions set forth in the beginning of the study, and therefore, inclusion of subject F's test results would significantly and unduly skew the analysis of the effectiveness of the study in a negative manner.

There was a significant difference in the accuracy between the two methods of input ($p<0.05$). Using the Boshiamy method, the accuracy was more controlled and typos were fewer. Additionally, according to the questionnaire filled out by the subjects after they had completed the course, all of them (i.e. 100%) experienced more confidence in their typing skills ability using the Boshiamy method, however, their typing speed, both for the children and the adult subjects, did not improve ($p<0.05$) as compared to using the original method of input. In fact, only subject B reached 14 characters per minute which was somewhat close to our preset goal of 15 characters per minute. We inferred that the subjects did not improve their typing speeds because 1) they had a great deal more experience using the original method of input in that that's the method they had used for many years prior and 2) a ten-week period to learn and adapt to the new method seemed insufficient, especially for the adults who had lowered learning flexibility.

5.2 Learning Curve

In this section, the subjects' typing effectiveness was examined. Specifically, this parameter examined the effectiveness of the subjects' typing skills taking into consideration the number of correct characters typed as well as the number of typing errors (e.g. typos), both missing and unnecessary. According to the learning progression, the results showed that the children, on average, improved more than did the adults. This phenomenon was preliminarily analyzed by the researchers' observations including individual subject interviews.

Several themes emerged from the interviews and observational data. Due to limited space, the discussion focused on the differences between the two learning groups and the obstacles they had in common:

i. Differences between the two learning groups

(a) Curiosity and attitude toward learning the new method: It has been suggested that curiosity is closely related to learning and motivation (Gregory, Lisa & Anthony, 1993; Borowske, 2005). On one hand, we found that the children seemed to maintain a higher degree of curiosity and attention throughout the duration of the study than did the adults. It also seemed that they felt the Boshiamy decoding system was interesting and that they experienced a sense of achievement when they responded correctly. On the other hand, it seemed as if the adults viewed the instruction as an opportunity to gain new knowledge but, at the same time, their interaction was more passive than that of the children's.

(b) The external factors: The adult subjects all had daytime or part-time jobs. For this reason, the amount of time they had to spend on studying the new input method was more limited as compared to that of the children. Also, it seemed that their enthusiasm for learning was also less that that of the children's. Also, in that they were still required to work efficiently during time

spent at their day jobs, they continued to rely mostly on using the original method of input. On the contrary, the children were in school where they could find immediate solutions to the problems they were experiencing and more fundamental material for practicing the new method. Also, the children didn't have as much pressure to obtain the required typing speed as did their adult counterparts.

(c) Maturity: It also appeared that the children followed their parent's instruction without too much resistance whereas the adult seemed inclined to have more personal views and challenges toward the new method of input.

ii. Common obstacles experienced among subjects

(a) The subjects had to first know and understand the structure of the characters or they would not be able to decode nor type it.

(b) Some components used in the common characters were more than five strokes in length which made them more difficult to remember.

6. CONCLUSIONS

This preliminary study was intended to establish a multi-learning system for the congenitally blind to learn the Boshiamy method of input. Both performance assessments and field studies were conducted as part of the study. According to the typing assessments during the ten week period that the study was conducted, it was observed that all of the subjects' number of typing errors went down and that their overall typing confidence was enhanced but, at the same time, the overall typing speed was still slower than it was using the original method of input. The findings reflected that the group of children experienced better learning progression than did the adult group. Although the study sample was small, the results can serve as a general basis for further study in the learning system of Chinese input method for the congenitally blind.

ACKNOWLEDGEMENTS

We would like to acknowledge the National Library of Public Information and the Institute for the Blind of Taiwan for their cooperation in this research.

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