Validation of the Chinese Handwriting Analysis System (CHAS) for primary school students in Hong Kong

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ABSTRACT

There are more children diagnosed with specific learning difficulties in recent years as people are more aware of these conditions. Diagnostic tool has been validated to screen out this condition from the population (SpLD test for Hong Kong children). However, for specific assessment on handwriting problem, there seems a lack of standardized and objective evaluation tool to look into the problems. The objective of this study was to validate the Chinese Handwriting Analysis System (CHAS), which is designed to measure both the process and production of handwriting. The construct validity, convergent validity, internal consistency and test–retest reliability of CHAS was analyzed using the data from 734 grade 1–6 students from 6 primary schools in Hong Kong. Principal Component Analysis revealed that measurements of CHAS loaded into 4 components which accounted for 77.73% of the variance. The correlation between the handwriting accuracy obtained from HAS and eyeballing was $r = .73$. Cronbach's alpha of all measurement items was .65. Except SD of writing time per character, all the measurement items regarding handwriting speed, handwriting accuracy and pen pressure showed good to excellent test–retest reliability ($r = .72$–.96), while measurement on the numbers of characters which exceeded grid showed moderate reliability ($r = .48$). Although there are still ergonomic, biomechanical or unspecified aspects which may not be determined by the system, the CHAS can definitely assist therapists in identifying primary school students with handwriting problems and implement interventions accordingly.

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1. Introduction

1.1. Chinese handwriting performance

Handwriting is a survival skill for students and they are expected to develop proficient handwriting skills in order to carry out their school work. In particular, handwriting is one of the most important means of determining the academic abilities of students in the Chinese educational system and students usually start their journey of writing since preschool age. When they are promoted to the primary school, over 50% of their time spent in school is involved in handwriting tasks (Tseng & Chow, 2000). Poor handwriting abilities may have adverse effect on students' performance in tests and public examinations.

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Apart from academic success, failure to attain handwriting competency during the school-age years has long-term negative effects on students' self-esteem (Feder & Majnemer, 2007). According to the Hong Kong Monthly Digest of Statistics (2009), there are about 9900 students with Specific Learning Difficulties (SpLD) in 2009. According to Chan's study in 2007, there are approximately 1 out of 10 students in Hong Kong having handwriting problems (Chan, Ho, Tsang, Lee, & Chung, 2007).

Unlike the alphabetic languages such as English that emphasize smoothness and continuity in their written forms, Chinese characters are logographic in nature and its complexity with multiple-stroke sequence and directions (Lam, Au, Leung, & Li-Tsang, 2011). Complex geometric figurations and stroke arrangements within a squared area are involved in Chinese handwriting (Chow, Choy, & Mui, 2003; Tan, Feng, Fox, & Gao, 2001). If a child writes "Iam ab oy", the teacher can still guess the meaning (I am a boy) even though the spacing between the letters is incorrect. However, if a child writes the Chinese character with wrong strokes or radical positions and spacing, it can become another character with a very different meaning. Thus, writing proficiency in Chinese is more demanding than writing in English (Lam et al., 2011). Moreover, handwriting evaluation tools developed to assess English writing may not be applicable to evaluate Chinese handwriting.

1.2. Identification and evaluation of students with Chinese handwriting difficulties

The Chinese handwriting evaluation tools currently available to assess primary school students' handwriting skills are the Tseng's Handwriting Speed Test (Tseng & Hsueh, 1997), the Handwriting Ability Checklist (HAC; Tam, 2008), and the Penmanship Objective Evaluation Tool (Rosenblum, Parush, & Weiss, 2001, 2003; Rosenblum, Weiss, & Parush, 2003). However, these handwriting assessments are weak as they fail to measure handwriting accuracy and legibility.

1.2.1. The Tseng's Handwriting Speed Test

The Tseng's Handwriting Speed Test (Tseng & Hsueh, 1997) is the most commonly used evaluation tools used to assess primary school students' handwriting speed. It was developed in Taipei to assess Chinese handwriting speed of students from grade 2 to grade 6. Students were asked to copy a text with 475 characters on an A4-sized paper with pre-printed grids as fast and as legible as possible for 5 min. All the characters were studied in the second semester of the grade 1 in Taiwan primary school curriculum. The number of characters copied was counted manually and the writing speed was calculated. Normative study was conducted on 1525 subjects in Taipei area. Good test–retest reliability was found ($r = .98$). However, as the test was specifically validated in relevance to the population and school curriculum in Taipei, it may not be valid to be used in Hong Kong.

1.2.2. Handwriting Assessment Checklist (HAC)

Handwriting Assessment Checklist (HAC) was a locally developed and validated handwriting evaluation checklist (Tam, 2008). It consisted of 10 questions concerning 3 domains of handwriting: writing process, writing product, physical and emotional well-being. Either teachers or parents could score it. The total score of the HAC ranged from 0 to 40. Increase in score represented decrease in handwriting proficiency. Test–retest reliability for both teachers and parents was good for the total score of HAC with high Intraclass Correlation Coefficient (ICC). For teacher, $r = .92$ and for parents, $r = .84$. Significant with moderate degree of relationship was found between the rating of parents and teachers ($r = .61$). Internal consistency of the total score of HAC was good with Cronbach's alpha = .94 for the rating of teacher and .80 for that of parents. The Content Validity Index (CVI) of relevance and clarity of all items ranged from .78 to .89. Principal Component Analysis showed that the question items loaded on the same construct of handwriting as proposed in the HAC. However, HAC can only primarily screen students' handwriting skill and identify those at risk of handwriting difficulties. It cannot provide specific information on a student's handwriting skill such as the handwriting speed and the percentage of handwriting accuracy. Further handwriting evaluation is required to further examine the severity and the underlying problems of students with handwriting difficulties.

1.2.3. Penmanship Objective Evaluation Tool (POET)

The Penmanship Objective Evaluation Tool (Rosenblum, Parush, & Weiss, 2001; Rosenblum, Parush, et al., 2003; Rosenblum, Weiss, et al., 2003) was the only digital-based handwriting evaluation tool developed locally to assess students' handwriting skill including total writing time, writing speed, and writing pressure exerted on the writing surface. Students were required to copy two Chinese templates, one with 6 characters and one with 20 characters on a WACOM digitizer in front of a laptop computer. It could capture the data generated from the WACOM tablet to assess the writing speed, the ground time, pen in air time, and pen pressure. Previous studies also adopted the POET to measure the handwriting process of children (Poon, Li-Tsang, Weiss, & Rosenblum, 2010). However, the POET could only measure the students' handwriting speed, pen in air time, ground time and handwriting pen pressure. The handwriting legibility and accuracy remained difficult to be captured using the POET system. In addition, the POET system has not yet been commercialized for clinical application.

Apart from the above handwriting evaluation tools, there are also a few preliminary development of tools in recent years, such as the Chinese Handwriting Assessment Program (CHAP) which is a preliminary development of computer-assisted assessment of Chinese handwriting performance (Chang, Yu, & Shie, 2009). It was written in the MATLAB language and based on the Tseng Checklist and the Elementary Reading and Writing test (Hung et al., 2003, as cited in Chang et al., 2009) to evaluate the neatness and legibility of Chinese handwriting. The program adopted a template-matching approach and could measure size control, spacing, alignment, and the average resemblance between standard models and handwritten