INSTRUMENT DEVELOPMENT AND ASSESSMENT OF HANDWRITING DIFFICULTIES AMONG PRIMARY SCHOOL STUDENTS IN PENANG

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INSTRUMENT DEVELOPMENT AND ASSESSMENT OF HANDWRITING DIFFICULTIES AMONG PRIMARY SCHOOL STUDENTS IN PENANG

by

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TABLE OF CONTENTS

CHAPTER 2 LITERATURE REVIEW

CHAPTER 4 DEVELOPMENT OF INSTRUMENTS

LIST OF TABLES

Page

LIST OF FIGURES

LIST OF APPENDICES

PEMBANGUNAN INSTRUMEN DAN PENILAIAN MASALAH TULISAN TANGAN DALAM KALANGAN MURID SEKOLAH RENDAH DI PULAU PINANG

ABSTRAK

Kajian ini meninjau profil kesukaran tulisan tangan bahasa Melayu dalam kalangan murid sekolah rendah. Alat penilaian tulisan tangan bahasa Melayu digunakan untuk mengumpul data daripada kumpulan sasaran ini. Kaedah campuran korelasi terbenam yang didekati telah digunakan dalam kajian ini. Reka bentuk ini membenamkan komponen kualitatif dalam reka bentuk kuantitatif. Untuk menjawab persoalan kajian, dua alat penilaian tulisan tangan Bahasa Melayu telah dibangunkan untuk mengakses prestasi tulisan tangan Bahasa Melayu (MyHA) kanak-kanak dan penanda yang berkaitan dengan tulisan tangan Bahasa Melayu (MyHM). Kedua-dua alat penilaian ini telah dibangunkan berdasarkan suatu rangka kerja pembangunan alat penilaian. Kedua-dua alat penilaian ini telah melalui kesahan kandungan dan semakan kebolehpercayaan ujian-uji semula untuk semakan kualiti. Data yang dikumpul daripada alatan tersebut digunakan untuk menghasilkan profil kesukaran tulisan tangan. 42 kanak-kanak sekolah rendah kebangsaan di Pulau Pinang telah diambil untuk kajian ini menggunakan skim persampelan kaedah campuran. Kanak-kanak ini (21 lelaki dan 21 perempuan) berumur antara tujuh hingga dua belas tahun telah disaring melalui MyHA dan MyHM untuk prestasi tulisan tangan Bahasa Melayu mereka dan penanda tulisan tangan yang berkaitan. Penulis tangan mahir (n=17) dan tidak mahir (n=25) dikenal pasti berdasarkan MyHA. Penulis tangan yang tidak mahir ialah mereka yang melaporkan skor prestasi tulisan tangan di bawah kriteria cut-off yang ditetapkan. Penulis tangan yang tidak mahir didapati juga mempunyai penanda tulisan tangan Melayu yang lebih lemah berbanding penulis

tangan yang mahir. Mengikut penemuan, tulisan tangan mempunyai kaitan yang signifikan dengan elemen persisian dan ciri bahasa. Prestasi tulisan tangan didapati berkorelasi dengan penanda tulisan tangan, yang terdiri daripada faktor kognitif, unit pemprosesan bahasa, maklum balas proprioception, persepsi visual, elemen-elemen kemahiran motor, postur duduk dan kemahiran memanipulasikan pensel. Ini menunjukkan bahawa kesukaran tulisan tangan mungkin berkaitan dengan penanda tulisan tangan Melayu ini. Oleh itu, faktor-faktor ini harus dipertimbangkan dengan prestasi tulisan tangan apabila menilai kesukaran tulisan tangan dalam kalangan kanak-kanak, untuk menentukan intervensi yang sesuai bagi menambah baik tulisan tangan kanak-kanak.

INSTRUMENT DEVELOPMENT AND ASSESSMENT OF HANDWRITING DIFFICULTIES AMONG PRIMARY SCHOOL STUDENTS IN PENANG

ABSTRACT

This study explores the profile of Malay handwriting difficulties among primary school students. Malay handwriting assessment tools were used to collect the data from this targeted group. The embedded correlational mixed-method approached was employed in this study. This design embedded a qualitative component within a quantitative design. To answer the research questions, two self-developed Malay handwriting assessment tools were developed to access children's Malay handwriting performance (MyHA) and the markers related to Malay handwriting (MyHM). Both tools were developed based on an assessment tool developmental framework. Both tools went through content validity and test-retest reliability check for quality check. Data collected from the tools were used to create the profile of handwriting difficulties. 42 students from national primary schools in the Penang Island were recruited for this study using the mixed-method sampling scheme. These students (21 males and 21 females), aged between seven to twelve years were screened through MyHA and MyHM for their Malay handwriting performance and the related markers of handwriting. Proficient (n=17) and non-proficient (n=25) handwriters were identified based on the MyHA. Non-proficient handwriters were those reporting the scores of handwriting performance below the cut-off criteria. The non-proficient handwriters appear to have poorer Malay handwriting markers compared to the proficient handwriters. According to the findings, handwriting is significantly correlated to the peripheral elements and language characteristic. The handwriting performance was found to be correlated to the related markers, which consists of the cognitive factors, language processing

units, proprioception feedback, visual perception, peripheral elements, sitting posture and pencil manipulation. This suggests that handwriting difficulties may be related to these underlying markers. These markers should therefore be considered with a handwriting performance when assessing whether a student is presented with handwriting difficulties, so to determine appropriate accommodation the student needs to improve handwriting.

CHAPTER 1

INTRODUCTION

1.1 Introduction

This study aimed to investigate the Malay language handwriting difficulties among primary school children in Penang. The Malay language is the national language of our country, and it has been widely used as the medium in all national schools. The transparency of the language and its salient syllabic characteristic which differs from the English language are believed to influence handwriting (Lee, 2014). Therefore, there is a need to study Malay language handwriting and its related markers to understand the fundamentals of handwriting difficulties in the Malay language (Lee et al., 2022).

Question regarding dysgraphia or impairment in written expression (DSM-5) might arise when discussing on handwriting difficulties, as dysgraphia was commonly recognized as learning difficulties related to handwriting. According to Fletcher-Flinn (2016), dysgraphia is defined as writing disorder specifically in spelling, and illegible handwriting. It should be noted that handwriting difficulties are only one of the symptoms of dysgraphia. Handwriting legibility alone cannot be seen as the sole determiner of dysgraphia. It should be clear that this study focuses on the Malay handwriting difficulties and not on dysgraphia. However, this study hopes to bring insight to the handwriting assessment of a dysgraphia screening tool by providing the fundamental of handwriting.

This study targeted participants age seven to twelve, who study in Penang national primary schools in order to investigate the fundamentals of Malay handwriting, this includes the handwriting performance and related skills. Students with handwriting difficulties struggle to write legibly. They show difficulties in producing appropriate letter form, letter size, word spacing, and alignment when writing. (Rahim & Jamaludin, 2019; Yusop & Alvin, 2010), and this difficulty affects academic achievement. Handwriting performance could be observed through the product of handwriting, and it is influenced by the handwriting markers of a child (Mathies & Schneck, 2006; Olive, 2011).

It has been a widely adopted practice in many countries including Malaysia that teachers in schools identify and then refer students with handwriting difficulties to occupational therapists for handwriting intervention (Donica, 2010a; Feder et al., 2000). In fact, it became the primary reason for referral to occupational therapy (Donica, 2010b). During the 1980s to 1990s, large numbers of students were being referred to occupational therapy for handwriting difficulties (Donica, 2010a; Reisman, 1999). In this situation, where the responsibility for remedial instruction of handwriting rested between occupational therapy and educational studies disciplines, there is a need to study handwriting from an interdisciplinary perspective as both educational studies and occupational therapy disciplines are directly related to handwriting. Therefore, this study proposes interdisciplinary research on Malay language handwriting between the occupational therapy and the educational studies disciplines.

1.2 Background of the Study

Students in Malaysian national schools acquire handwriting skills in the Malay language when they start primary school. However, as there are no specific curriculum or structured training and instruction exclusively for handwriting, students usually acquire handwriting through informal instruction while performing their daily school tasks. The similar phenomena were observed in many other countries where students are expected to acquire a certain level of proficiency in handwriting skills as they start school, to enable them to carry out their work at school (Collette et al., 2017; Dockrell et al., 2018; Sakamat & Khalid, 2018). Writing by hand makes up approximately 60% of school activities and this task of writing by hand keeps increasing across grades or school years (Collette et al., 2017; Marr et al., 2003). The society often takes for granted the ability to perform handwriting, many believe that children pick up handwriting skills naturally through daily tasks (Erhardt & Meade, 2005), especially in today's digital world which focused more on keyboard writing. Despite the neglect of handwriting instruction, handwriting is an expected skill necessary for school-age students to function in a mainstream classroom (Collette et al., 2017; Dockrell et al., 2018; Sakamat & Khalid, 2018; Schneck & Case-Smith, 2015).

Writing is an act of communication (expression) through a written system which is affected by the orthography of that particular writing system, that involves complex processes. Hayes and Flower's (1980) influential model of writing identified three components (planning, translating, reviewing) that underline the writing process. After decades of research and studies, Berninger and colleagues (1996) improved the model by adding two sub-fundamental processes which represent the production of text to the model, namely transcription and text

generation. Juel (1988) also referred to these two fundamental processes (refer Wengelin & Alfe, 2018) as the basic of writing in the Simple View of Writing model. The transcription component refers to the ability to convert linguistic representations into written symbols (orthography), which includes handwriting and spelling (Berninger, 1999; Tse et al., 2014). On the other hand, text generation skills component refers to the ability to generate ideas into language presentation in memory. This research only focuses on the basic transcription component, which is the handwriting component.

Handwriting is a process of producing or transcribing letters to form words, and from words to form sentences, which is related but different from writing or composing (Connelly et al., 2011; Graham, 1999; 2018; Medwel & Wray, 2008; Myers, 2006). Poor handwriting skills affect the writing process (Abdul Rashid, 2011), such as causing cognitive overload (Berninger, 1999; Berninger, et al,, 1998), whereas good handwriting ability allows sustainable quality writing (Alves, et al., 2012). Good handwriting is also known as, proficient writing which is built on well-developed handwriting skills (Dinehart, 2015; Graham, 2018; Myers, 2006; Tolchinsky & Jisa, 2018). Although handwriting was described as the basic skills of writing or composing (Abdul Rashid, 2011) but it was often unappreciated (Graham, Berninger, et al., 1998).

A deeper understanding of the fundamental processes of Malay language handwriting will allow new insights to solve Malay handwriting difficulties. According to Bazerman et al. (2017), handwriting involves multi-dimensions that develop across experiences, each experience brings all the dimensions together in a unified communicative event. For example, when teaching handwriting, students may encounter challenges from other dimensions. Handwriting difficulties may arise

from insufficient executive attention (overloaded working memory), poor peripheral abilities (lack of motor skills), or difficulties in manipulating writing tools (biomechanical ergonomic factors) or some other combination of these difficulties (Cornhill & Case-Smith, 1996; Olive, 2014). The acquisition of handwriting relies on the development of each dimension that is involved together in writing. The complexity and multidimensional portrait of handwriting development suggests the need to address all the elements related to handwriting (including language system (orthographic), biomechanical ergonomic factors, neuro-motor development, and central executive control) to gain a deeper understanding on handwriting.

Handwriting difficulties can be accounted as an occupational therapy performance, since handwriting is considered a daily demanding task for school-going children (Rosenblum, 2008). Occupational therapists play an important and unique role to evaluate and treat children with handwriting challenges through the assessment of neuromuscular (motor and praxis performance) skills, sensorimotor (sensory perceptual) skills and their handwriting function and ability (Donica, 2010b; Erhardt & Meade, 2005). Occupational therapists perform evaluation of the underlying motor and sensory issues that may affect handwriting performance (Donica, 2010a). In some countries, occupational therapists also provide in-service training to educators and the public through seminars and workshops to train teachers on handwriting skills and development (Schoenfeld et al., 2009).

Most handwriting interventions in occupational therapy assume that sensorimotor impairment caused the handwriting difficulties, and this assumption is derived primarily from correlation studies (Denton et al., 2006; Kapnick, 2004). The related sensorimotor fundamental processes include visual perception, kinesthesia, in-hand manipulation, and visual-motor integration. The assumption resulted in the

focus of sensorimotor skills in the handwriting interventions (Denton et al., 2006). According to Feder and Majnemer (2007), many occupational therapists assess gross and fine motor skills, perceptual skills, quality of movement, and motor planning in children with handwriting difficulties, and also biomechanical ergonomic factors such as body posture and pencil grip among handwriting assessment (Amundson, 1995).

Teachers and educators usually assess handwriting only from the aspect of the handwriting product (Graham, 2018), which contrasts with occupational therapists who assess handwriting mainly based on the assessments of handwriting markers, which are the underlying neuro-motor development mechanisms of handwriting. Both perspectives showed some overlaps but with different focal points due to the difference in philosophy that each discipline holds.

This researcher found an overwhelming amount of cumulative knowledge from the merging of literature review from these two major disciplines which needed to be consolidated in order to obtain the full picture of the handwriting processes and the possible difficulties that underlie the handwriting task. A Malay handwriting interdisciplinary framework is developed based on the interdisciplinary literature review conducted by the researcher (refer to Figure 2.6 in Chapter 2). This framework identified six factors that underlie handwriting tasks which are the central executive, linguistic processing units, sensory feedback, peripheral elements, biomechanical ergonomic factors, and ergonomic factors. This Malay handwriting interdisciplinary framework guides the development of two Malay handwriting assessment tools in order to measure the performance and markers of Malay handwriting.

Handwriting performance assessment evaluates the performance of handwriting (e.g. quality and fluency), whereas handwriting markers assessment applies additional measures such as neurodevelopment factors or certain components in the process that are related to handwriting, and it is grounded in theory (Berninger et al., 1996). The handwriting performance refers to the quality and fluency of a handwriting product. The assessment of handwriting markers refers to the underlying developmental markers in the Malay language handwriting (this includes central executive, linguistic processing units, sensory feedback, peripheral elements and biomechanical ergonomic factors). This study assessed both the handwriting performance and the handwriting markers of Malay language among participants using two self-developed Malay handwriting assessment tools in order to achieve a clearer understanding of the Malay language handwriting difficulties. The assessment tools were used to gather data of the students' handwriting profiles and from the profiles, students at risk of having Malay handwriting difficulties can be identified.

1.3 Problem Statements

Handwriting has been studied substantially in various disciplines and population, and this provides understanding of the complexity of the processes involved. However, these knowledge are fragmented since most of the studies were carried out separately, very few have combined different perspectives. There is a lack of an integrated picture of handwriting development as a multidimensional process (Bazerman et al., 2017). Students are expected to master handwriting when they start school and to cope with the learning activities at school which largely involve handwriting, and teachers need other professionals to assist in teaching those who struggle with handwriting, (e.g., physiotherapist and occupation therapist) (Alston &

Taylor, 1987). Many students who struggle with handwriting usually will be referred to the occupational therapist for treatment (Feder et al., 2000). Currently, it is the occupation therapist's role to analyze handwriting (underlying deficit: postural control, sensory integration, sensorimotor, perceptual, and behavioural elements etc.) (Cornhill & Case-Smith, 1996). According to Hayes and Berninger (2014) handwriting is influenced by orthography and phonology, whereas occupation therapists believe it is influenced by motor-related skills (Tseng & Cermak, 1991) and does not look at handwriting from the perception of education practitioners, but their focus is on the development of sensorimotor in treating handwriting difficulties (Feder et al., 2000). Furthermore, occupational therapists tend to view handwriting in terms of prerequisite skills, whereas teachers view handwriting from a literacy standpoint (Donica & Holt, 2018; Patton et al., 2015). Clearly, there is a need to close the gap of this dichotomy of disciplines in handwriting research. This study works to combine both disciplines, by looking from the perspectives of educational and occupational therapy disciplines, and also to fill the gap by bridging the knowledge from both disciplines, in the hope of a better understanding not only of the handwriting performance but also of the underlying mechanism of handwriting among primary school students with Malay handwriting difficulties.

There is a need to integrate knowledge and methods from the different disciplines to investigate the Malay handwriting difficulties among primary school students from an interdisciplinary approach. This includes students' Malay handwriting performance and markers of Malay language handwriting. The cumulative knowledge from the synthesis of the literature review from the two major disciplines is overwhelming, careful study is needed to make sense of the synthesized markers of handwriting and handwriting performance among students who are

experiencing persistent handwriting difficulties. The handwriting markers include (1) central executive that controls and regulate the attentional resource and working memory during handwriting, (2) linguistic processing units that consist the mastery of the production of the alphabetic letters and the orthography coding ability, (3) four sensory feedback that are related to handwriting (tactile, kinaesthesia, proprioception, and visual perceptual), (4) peripheral elements which include eye-hand coordination, in-hand manipulation, visual-motor integration, and bilateral coordination, (5) biomechanical ergonomic factors which involved the sitting posture when performing handwriting, pencil and paper manipulation. This will be further explained in the following chapter.

Difficulties arise when reviewing the literature across disciplines of education and occupational therapy respectively (refer to chapter 2). First, the different terms used from the various fields denoting similar processes and items in the research can be quite confusing. Second, the different focus across disciplines, and third, the confusing categorization of elements or fundamental processes or factors related to handwriting. These would be an obstacle for teachers and service providers to fully understand handwriting difficulties among children. Therefore, there is a need to consolidate evidence-based practices across disciplines to determine the markers of handwriting. The consolidation across disciplines will narrow down more succinctly the sub-constructs that are essential for handwriting and at the same time, to weed out the weaker factors. An interdisciplinary study on handwriting which integrates knowledge and methods from different disciplines is timely. Therefore, this research aims to conduct an interdisciplinary review in order to develop two instruments that are practical for both teachers and therapists to assess the handwriting markers and Malay handwriting performance (Malay handwriting performance) of primary school

students in order to determine the students' handwriting profiles. The development of these assessment tools for Malay handwriting is needed because currently there is no Malay handwriting assessment on the markers of handwriting and very scares Malay handwriting performance assessment.

The Malay language is the national language in Malaysia and is the official language of communication especially in the government agencies, and it is the medium of teaching and learning in all the national schools in Malaysia. Language is an important factor in handwriting; however, the orthography of a language has received less attention in handwriting research (Zivianni & Wallen, 2006). Even, Hayes and Berninger (2014)'s model did not highlight the effects of language (refer O'Rourke et al., 2018).

The handwriting markers are unique to each language since the grammatical rules in each language dictate the letter arrangements in words and the phoneme-grapheme correspondences (Kandel et al., 2009), For example, the phoneme-grapheme correspondence and the number of syllables in a word can affect handwriting speed (Kandel, Alvarez, et al., 2006; Lambert et al., 2008). The orthographic coding skill and the orthographic motor integration skill are more subjective to language effect as the word structure and the phoneme-grapheme correspondence in a language can potentially dictate the speed of orthographic coding and orthographic motor integration. The Malay language is predominantly bi- and multi-syllabic (Lee et al., 2013), which is different from the English language. Unfortunately, the fundamental mechanisms of Malay language handwriting have been less studied and reported. Therefore, there is a need to study the fundamentals of handwriting from the perspective of the Malay language to reduce the knowledge gap regarding the fundamental mechanisms that underlie handwriting difficulties in

the Malay-alphabetic script (Malay handwriting) among students with handwriting difficulties.

Handwriting assessments and interventions have yet to become commonplace in Malaysia and are not a major component in the school curriculum, probably due to the general ignorance towards the importance of handwriting in academic learning. A search on local literature using handwriting keywords (e.g., handwriting, *tulisan tangan*, *penulisan*, *kemahiran menulis*) revealed some articles related to handwriting in the local context such as on teachers' knowledge about handwriting of students with special needs (Hamid & Alias, 2017; Hamid & Yasin, 2020); improving of neatness in handwriting (Daud & Shaari, 2013); pencil grip (Lim et al., 2012); intervention for children with dysgraphia (Gunarhadi et al., 2017). The above literatures revealed obvious gaps in the understanding of the fundamental mechanisms that underlie handwriting difficulties among young students who struggle to write the Malay language.

Today, a noticeable number of students in schools are struggling with handwriting (Conti, 2012; van Hartingsveldt et al., 2011). Handwriting has often been identified as a variable affecting successful participation in school (Donica, 2010b). Research evidence available also illustrates the positive impact of handwriting on the performance across all academic learning such as reading, writing, and language (Cameron et al., 2012; Graham et al., 2000; James & Engelhardt, 2012; Kulp, 1999). Therefore, handwriting difficulties can significantly relate to academic failure (Graham et al., 2000) since handwriting task account for 30-60% of school activities (McHale & Cermak, 1992).

Furthermore, the challenges in handwriting may affect attitude and motivation for task that involve writing (Graham & Weintraub, 1996; Graham et al., 2000). Difficulties in acquiring handwriting skills may lead children to develop avoidance of writing tasks and a mind-set that they cannot write (Berninger, 1999; Berninger, Mizokawa, et al., 1991; Graham et al., 2000). All these have marked the urgent demand of a fundamental handwriting study among students with handwriting difficulties in Malaysia.

This study therefore aims to develop Malay language handwriting assessment tools in effort to assess the Malay handwriting performance and markers from a representative sample of primary school students in Penang, Malaysia. The students' handwriting performance is presented as their handwriting profile which consists of the results of their handwriting performance and markers.

1.4 Research Purpose

This research aims to develop instruments to assess both the Malay handwriting performance (product) and the markers (underlying mechanisms) of Malay-alphabetic handwriting difficulties based on the integrated perspective of two major disciplines which are the educational discipline (e.g., handwriting legibility, handwriting speed, central executive and linguistic processing units) and the occupational therapy discipline (e.g., neuro-motor skills, sensory feedback, and ergonomic factors). Subsequently, the research aims to use these assessment tools to investigate the handwriting profiles of students with handwriting difficulties.

1.5 Research Objectives

Specifically, this study aims to:

1. To develop an instrument (Malay Handwriting Assessment Tool, MyHA) to assess the Malay handwriting performance (legibility, endurance, and speed) based on interdisciplinary literature review.
2. To determine the content validity of the self-developed instrument (Malay Handwriting Assessment Tool, MyHA).
3. To determine the test-retest reliability of the self-developed instrument (Malay Handwriting Assessment Tool, MyHA).
4. To develop an instrument (Malay Handwriting Markers Assessment Tool, MyHM) to assess the underlying neuro, sensory, and motor mechanisms (central executive, linguistic processing units, sensory feedback, peripheral elements, and biomechanical ergonomic factors) of Malay handwriting difficulties based on interdisciplinary literature review.
5. To determine the content validity of the self-developed instrument (Malay Handwriting Markers Assessment Tool, MyHM).
6. To determine the test-retest reliability of the self-developed instrument (Malay Handwriting Markers Assessment Tool, MyHM).
7. To determine the correlations between the Malay handwriting performance and the markers of Malay handwriting.
8. To compare the Malay handwriting performance and the markers of Malay handwriting of students with and without handwriting difficulties.
9. To determine the handwriting profiles of students with Malay handwriting difficulties.

1.6 Research Questions

1. How should an instrument to assess the Malay handwriting performance (legibility, endurance, and speed) be developed based on interdisciplinary literature review?

2. What is the content validity of the Malay Handwriting Assessment Tool, MyHA?

3. What is the test-retest reliability of the Malay Handwriting Assessment, MyHA?

4. How should an instrument to assess the markers (central executive, linguistic processing units, sensory feedback, peripheral elements, and biomechanical ergonomic factors) of Malay handwriting difficulties be developed based on interdisciplinary literature review?

5. What is the content validity of the Malay Handwriting Markers Assessment Tool, MyHM?

6. What is the test-retest reliability of the Malay Handwriting Markers Assessment Tool, MyHM?

7. What are the correlations between Malay handwriting performance and the markers of Malay handwriting?

8. How do the Malay handwriting performance and the markers of Malay handwriting differ between students with and without Malay handwriting difficulties?

9. What are the handwriting profiles (Malay handwriting performance and markers of Malay handwriting) of students with Malay handwriting difficulties?

1.7 Significance of the Study

This study contributes new knowledge on the markers of handwriting in general based on an interdisciplinary approach between two disciplines which are highly related to handwriting. The lack of an integrated picture of handwriting has left policy planners with fragments to paste together (Bazerman et al., 2017). This study will create new foundational knowledge for the future research on handwriting in Malaysia. Such groundwork will help to direct policies to provide better services for students who struggle with handwriting.

Every language has a distinct characteristic which exert different demands on the processes of handwriting. This study is interested with the handwriting in the Rumi-alphabetic of Malay language in block letters. Handwriting research in the Malay language has been cursory thus far, without adequate in-depth investigation. The findings from this research will contribute new knowledge on Malay language handwriting difficulties. Therefore, this study contributes to the development of handwriting research in Malaysia, and expands the discipline of handwriting in general.

Factors that influence handwriting range from higher level cognitive skills to lower-level developmental skills. These high- and low-level processes constantly interact during handwriting (van Galen, 1991; Weintraub & Graham, 2000). The assessment tools developed from this research to measure handwriting difficulties in the Malay language among primary school students can help to identify students with handwriting difficulties and subsequently diagnose the underlying high- and low-level processes related to their handwriting problems.

This study contributed towards the design and development of these two Malay language handwriting assessment tools, which were evaluated for content validity and test-retest reliability. Teachers and therapists could use these assessment tools to identify handwriting difficulties among primary school students.

In-depth knowledge of the handwriting profile of students with Malay language handwriting difficulties obtained from this study will contribute towards an intervention framework which will be valuable input for future design and development of efficient handwriting intervention for students with Malay handwriting difficulties. This design and development of handwriting intervention in the future will be based on evidence-based practices.

Many researchers have investigated the possibility of typewriting in replace of handwriting for children who struggle with handwriting in the hope to find a solution for handwriting difficulties. However, research findings revealed the important and irreplaceable of handwriting. Therefore, instead of exploring the possibility of an alternative in replace of handwriting for those who are struggling, handwriting research should be encouraged.

According to the World Federation of Occupational Therapists (WFOT) president Marilyn Pattison, Malaysia have only 1400 registered occupational therapists which is the ration of 1: 20k (Wong, 2014). This shortage of registered occupational therapists is also common in many countries due to the profession's level of maturity. In Malaysia, 90% of occupational therapists work in hospitals. Which mean most students will not have access to occupational therapy without recommendation by doctors. Malaysia also has limited resource of professionals (e.g. child psychiatrists, paediatricians, clinical psychologists etc.). Limited access to

intervention, poor teaching instruction, and lack of assistants from the professional have badly impact the remediation of handwriting difficulties among the students who struggle with handwriting. This fundamental research aimed to produce Malay handwriting assessment tools which can be used by occupational therapists and educators.

1.8 Limitation

There may be some limitations in this study. The first is the limited access to the primary school students due to the pandemic (COVID-19) situation in the country. Therefore, the study employed the mixed method sampling design, using the random purposive sampling method to sample the appropriate size for the study. Many parents were reluctant to participate in this research because the handwriting assessments need to be done face to face. The second limitation concerns the lack of previous research studies on Malay handwriting. Previous studies constitute the foundation of the literature review for a research study, however there is a significant lack of Malay handwriting research available. A detailed and careful interpretation based on global literature is done to lessen the impact of this limitation. The researcher was aware of the wide age-range of the targeted respondents and has expected that the older students would perform better than the younger students, however, this being a feasible study, this condition is acceptable.

1.9 Delimitation

This study focuses only on the low level and fundamental process of transcription (handwriting) which does not include spelling. This study is interested in manuscript handwriting and not the cursive handwriting, this is because students are more familiar with manuscript handwriting, they do receive brief instruction on cursive handwriting but it is seldom used in handwriting task at school.

1.10 Operational Definition of Terms

1.10.1 Handwriting

Handwriting refers to the process of producing language symbols using a writing tool by hand (Maldarelli et al., 2016; Zivianni & Wallen, 2016). In this research, handwriting is operationalised as Malay language handwriting.

1.10.2 Malay Handwriting Performance

The handwriting performance is measured by product assessment. The product assessment of handwriting evaluates the performance of handwriting in terms of quality and fluency (Graham, Weintraub, et al., 1998). There are generally two types of product assessments namely, global assessment, and componential assessment. It will be further discussed in chapter two. In this research, Malay handwriting performance refers to the processes related to the production of written Malay language from the standpoint of componential assessment, which include handwriting legibility, handwriting speed, and handwriting endurance.

Handwriting legibility refers to the letterform, letter size, and word spacing that make up the readability level of a handwritten work. Handwriting speed is the speed of the production of handwriting, while endurance is the ability to maintain a legible handwriting in an extended period of time (eight minutes).

The Malay Handwriting Assessment (MyHA) is employed in this study to measure the Malay handwriting performance. It is a componential assessment tool to measure students' handwriting performance in the aspect of Malay language handwriting legibility, speed, and endurance.

1.10.3 Malay Handwriting Markers

In this study, the Malay handwriting markers refer to the underlying mechanisms of Malay handwriting. It includes central executive (executive attention and working memory), linguistic processing units (letter knowledge and orthographic coding), sensory feedback (Tactile, kinesthesia, proprioception, and visual perception), peripheral elements (eye-hand coordination, in-hand manipulation, visual-motor integration, and bilateral coordination), and biomechanical ergonomic factors related to handwriting (sitting posture, pencil manipulation, paper manipulation).

Assessment of handwriting markers measures fundamental process related to handwriting such as neuro, language, sensory, motor development, and biomechanical ergonomic factors. The Malay Handwriting Markers Assessment (MyHM) is a newly developed assessment tool designed to measure the underlying markers of Malay handwriting. The assessment tool is developed based on the Malay handwriting interdisciplinary framework from the interdisciplinary literature review (Lee et al., 2022).

1.10.4 Central Executive

Central executive refers to the central control during handwriting activity. This includes the regulation of attention during the process (executive attention) and the working memory involved during handwriting.

1.10.5 Linguistic Processing Units

Linguistic processing units include the mastery of the basic units of the Malay language script (the alphabetic letters) and the Malay language orthographic coding ability.

1.10.6 Sensory Feedback

Sensory feedback refer to the four sensory feedback that are related in the process of handwriting. They are the tactile, kinaesthesia, proprioception feedback and visual perception.

1.10.7 Peripheral Elements

Peripheral elements refer the motor skills that are involved in handwriting. There are four motor skills that influence handwriting, namely eye-hand coordination, in-hand manipulation, visual-motor integration, and bilateral coordination.

1.10.8 Biomechanical Ergonomic factors

The biomechanical ergonomic factors are the ergonomic factors that involved body parts when performing handwriting which are different from ergonomic factors that only involve writing tools and furniture (used during handwriting). The biomechanical ergonomic factors include sitting posture during handwriting, pencil manipulation (pencil grips, pencil grips consistency, and pencil positioning) and paper manipulation (paper stabilization and paper positioning).

1.10.9 Ergonomic Factors

Ergonomic factors refer to the tools that assist handwriting task. This includes the writing tools (e.g. pencil, pen) with different diameter, length etc., lined or unlined paper, and furniture (e.g. desk, chair). In this study, pencil and writing material (lined booklet) were set as control variables.

1.10.10 Proficient and Non-proficient Handwriters

Proficient handwriters refer to participants who score above the cutoff point in the MyHA. Non-proficient handwriters refer to those participants who scores below cutoff point in the Malay Handwriting Assessment tool (MyHA).

1.10.11 Students with Handwriting Difficulties

Handwriting difficulties are related to the deficit in perceptual-motor functions (Volman et al., 2006). In this research, students with handwriting difficulties are students who exhibit low performance in handwriting performance and markers based on the handwriting profile derived from the result of the Malay Handwriting Assessment (MyHA) and the Malay Handwriting Markers Assessment (MyHM).

1.10.12 Handwriting Profile

Handwriting profile refers to the Malay handwriting performance of a student which include handwriting performance and markers of the student. In this research, a complete handwriting profile of a student consists of both handwriting markers and handwriting performance (handwriting product). The Malay handwriting markers consist of variables namely, central executive, linguistic processing units, sensory feedback, peripheral elements, and biomechanical ergonomic factors. The Malay handwriting performance includes the legibility, speed, and endurance of Malay handwriting. The complete profile will be determined through the analysis of both descriptive quantitative data, as well as qualitative descriptions.

1.11 Conclusion

Handwriting is a necessary and fundamental skill for school going children to function in the mainstream classroom. It has become an essential variable affecting learning performance across all academic. Most previous works on handwriting are research-specific, encompass in each distinct discipline, which severely lacking cross-knowledge transfer across disciplines. This study sought to investigate Malay handwriting through interdisciplinary study between occupational therapy and educational studies disciplines. These two disciplines control the acquisition and

remediation of handwriting among school going children. The primary aimed of the study is to describe the handwriting profiles of students aged seven to 12 with handwriting difficulties. In order to achieve this, the performance of Malay handwriting performance and markers among the participants in this study are needed. However, no Malay handwriting assessment tools are known to date, for this reason developing Malay handwriting assessment tools is required. This study also measured the validity and reliability of the self-developed Malay handwriting performance assessment and handwriting markers assessment tools.

The result of this interdisciplinary study (1) creates new fundamental knowledge for future research on Malay handwriting, (2) new knowledge on Malay language handwriting difficulties, (3) assessment tools to identify students with handwriting difficulties, (4) in-depth knowledge on of handwriting profiles of students with Malay handwriting difficulties, and (5) contribute towards the design and development of future handwriting intervention. These findings may serve multiple stakeholders such as teachers, parents, occupational therapists etc.

This chapter presents an introduction of the study, background of handwriting, problem statements, research objectives and questions, significant of the study, limitation and delimitation of the study, and the operational definition of terms involved in this study. The following chapter is a comprehensive review of the literature on the topic, including the proposal of the Malay handwriting conceptual framework.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

According to Stember (1991), interdisciplinary study refers to the integrating of knowledge and methods from different disciplines. This chapter presents an overview of research studies and findings on handwriting from both the educational studies and occupational therapy disciplines, and subsequently the knowledge from these two disciplines was integrated into forming an interdisciplinary framework of Malay language handwriting in this study. Based on this framework, a battery of assessment tools which taps into the handwriting performance and the markers of Malay handwriting among primary school students are developed to identify the possible handwriting difficulties in the Malay language. Next, a conceptual framework which displays the variables being investigated in the present study is presented. This interdisciplinary study aimed to measure the variables that uniquely explain handwriting from both educational studies and occupational therapy perspectives in order to gain a deeper understand on the underlying developmental mechanisms of Malay handwriting.

There is a need to review older literature in this chapter to show historical development of of this area of research, and also, there was a switch of research interest from handwriting to functional writing and alternative writing in the 19th century, leaving a knowledge gap in this field. The act of reviewing older literature not only to acknowledge the pioneer works of the previous researchers but also as a foundational resources in this handwriting study for the future research, and to be more detail in bridging knowledge across two disciplines in this interdisaplinary study in order to provide clearer picture of the handwriting.

2.2 Handwriting Research in Malaysia

Literature related to handwriting in the local Malaysian context is scarce. In the recent years, local handwriting research in Malaysia that focused on handwriting assessment and intervention included the studies by Abdul Rashid, Hamid, Yasin, Alias, Daud, Sakamat, Khalid, Yusop, Alvin, Gunarhadi, and Lim.

Abdul Rashid (2011) investigated problems pertaining to reading and writing skills in the Malay language at rural primary schools in Sarawak among 161 children aged 11 and 12. Based on the questionnaire developed, he identified two writing problems among these children: (1) difficulty in differentiating upper and lower case of the letters, and (2) difficulty in identifying punctuation.

Hamid and Yasin (2020) reported a case-study of teachers' knowledge on teaching handwriting. In their study they proposed fine motor training to improve the handwriting for children with handwriting difficulties. Hamid and Alias (2017) also conducted a survey on teachers' knowledge in teaching handwriting to students at special education primary schools. Data were collected from 30 teachers. Based on the findings they concluded that teachers lack training to teach handwriting skills to children in special education school.

Daud and Shaari (2013) accessed the efficiency of a Malay handwriting intervention for improving the neatness in handwriting. They compared the pre and post result of three students using the 'Buku Ajaib Mari Menulis' intervention and found positive effect. Yusop and Alvin (2010) investigated mechanical handwriting problems related to children with dysgraphia through a case-study. The subject (Kamal) is a boy with dysgraphia. The study analyzed Kamal's handwritten product and the behaviour related to dysgraphia.