



Faculty of Cognitive Sciences and Human Development

**The Relationship of Handwriting, Spelling and Word Reading Accuracy
Among Multilingual Primary 1 Poor Readers**

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**Master of Science
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among Multilingual Primary 1 Poor Readers

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A thesis submitted

In fulfillment of the requirements for the degree of Master of Science

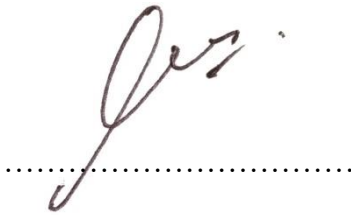
Faculty of Cognitive Sciences and Human Development

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2023

DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Malaysia Sarawak. Except where due acknowledgements have been made, the work is that of the author alone. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.



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ABSTRACT

This study aimed to investigate the relationship of handwriting, spelling and word reading accuracy among multilingual Primary 1 poor readers. A total of 866 Year 1 Malaysian government school students from various demographic and multilingual backgrounds participated in the research. Students with poor reading skills were classified according to percentile scores with the 25th percentile and below as the cut-off point. The reading (word reading accuracy), spelling (phonological coding) and handwriting (name and letter writing) outcomes were analysed. The findings show that a majority of poor readers, respectively in Malay and English, had poor handwriting and spelling skills. Spelling was a better indicator for identifying reading difficulties due to its high correlations with reading performance. Additionally, both poor readers and spellers correspondingly showed poor reading and spelling performances in both languages. These findings are useful for developing more appropriate tools to identify reading difficulties among Malaysian learners. Future directions and implications for practice are addressed.

Keywords: Reading difficulties; spelling; handwriting; Malay; English.

Peranan Tulisan Tangan dan Ejaan dalam Mengenal Pasti Kesukaran Membaca dalam Kalangan Murid Multilingual

ABSTRAK

Kajian ini mengetengahkan hubungan antara tulisan tangan, ejaan dan ketepatan bacaan perkataan dalam kalangan murid multilingual Darjah 1 yang lemah dalam pembacaan. Seramai 866 murid Darjah 1 sekolah kebangsaan yang berlatar belakang demografi pelbagai serta multilingual telah mengambil bahagian dalam kajian ini. Persentil ke-25 dan ke bawah telah digunakan sebagai aras penentu untuk mengkategorikan murid-murid yang mempunyai kesukaran dalam kemahiran membaca. Kemahiran membaca (ketepatan bacaan perkataan), ejaan (pengekodan fonologi) dan tulisan tangan (penulisan nama dan huruf) telah dianalisis. Hasil kajian menunjukkan bahawa ejaan adalah petunjuk yang lebih bagus untuk mengenal pasti kesukaran membaca, kerana ejaan mempunyai korelasi yang lebih tinggi dengan prestasi membaca. Selain itu, pembaca dan pengeja yang lemah masing-masing juga menunjukkan prestasi membaca dan mengeja yang lemah dalam kedua-dua bahasa. Dapatan kajian ini berpotensi untuk menghasilkan alat yang lebih sesuai untuk mengenal pasti kesukaran membaca dalam kalangan murid di Malaysia. Halatuju masa depan penyelidikan serta implikasinya telah dibincangkan.

Kata kunci: *Kesukaran pembacaan; ejaan; tulisan tangan; Bahasa Melayu; Bahasa Inggeris.*

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LIST OF ABBREVIATIONS

<i>M</i>	Mean Score
<i>p</i>	Probability Value
PC	Phonological Coding
<i>r</i>	Correlation Coefficient
RD	Reading Difficulties
<i>SD</i>	Standard Deviation
WRA	Word Reading Accuracy

CHAPTER 1

INTRODUCTION

1.1 Study Background

Adequate proficiency in reading and writing establishes the crucial foundation for learning and excellence in school and at the workplace (McCloskey & Rapp, 2017; Puranik & Al Otaiba, 2012). Conventional literacy skills encompass decoding, oral reading fluency, reading comprehension, writing, and spelling skills (National Early Literacy Panel [NELP], 2008). Over the years, the importance of conventional literacy skills comprising phonological-decoding, sublexical-fluency, and vocabulary-memory has been demonstrated in many studies on preschool to elementary school children (Hulme & Snowling, 2015; Lee et al., 2020; National Reading Panel, 2000; NELP, 2008).

Apart from decoding (i.e., reading) and spelling skills that were identified as conventional skills by the NELP (2008), handwriting is also considered as one of the vital skills in early literacy development (James, 2017; Reutzel et al., 2019). As handwriting and letter perception belongs to the same network of activation in the literate brain, handwriting experience plays a crucial role in the formation of brain network that facilitates letter recognition (James, 2017; James & Berninger, 2019).

1.2 Problem Statement

Reading difficulties (RD) affect approximately 5% to 15% of students worldwide (American Psychiatric Association, 2013). In Malaysia, approximately 15% of children in mainstream classrooms have some form of learning disabilities, including RD (Wong et al., 2019). Recent empirical findings suggest that 24% to 35% of the first graders in Malaysian

government primary schools are at risk of RD (Lee et al., 2020). In comparison to students from other parts of the world, 45.8% of 15-year-old Malaysian students failed to meet the minimum proficiency level in reading (Organization for Economic Cooperation and Development [OECD], 2019). These estimated prevalence rates suggest that the early detection of RD by school professionals such as teachers is an important research agenda. The early detection and diagnosis of RD are crucial but the empirical evidence on valid and suitable indicators of RD in Malaysia is, hitherto, still in its infancy (Lee, 2008; Lee et al., 2020).

Students with RD typically struggle to link the letter to its respective sound during word decoding (reading) and the sound to the letter(s) during encoding (spelling), which affects word recognition (Hudson et al., 2007). Students with RD have been reported to also experience handwriting difficulties, suggesting a high chance of comorbidity (Döhla et al., 2016; Gargot et al., 2020). Handwriting difficulties are manifested in writing letters/words fluently and legibly (Ashraf & Najam, 2020; Berninger et al., 2008; Hebert et al., 2018; Sumner et al., 2014). Based on the simple view of writing by Berninger and colleagues (2002), transcription skills are comprised of both handwriting and spelling and some students with transcription difficulties were reported to experience RD while some students do not (Berninger, 2007; Di Brina et al., 2018; Prunty & Barnett; 2017). Among typically developing children, researchers have discovered a positive correlation between the mastery of handwriting skills and their spelling success (Alamargot et al., 2020; Lichtsteiner et al., 2018; Pritchard et al., 2020; Ritchey, 2008); conversely, children with poor handwriting obtained lower scores in both reading and spelling outcomes (McCarney et al., 2013).

Compared to RD, there are fewer empirical studies on specific written expression disabilities (i.e., handwriting and spelling difficulties) (Berninger et al., 2018; Grigorenko et al., 2020). However, there is a growing interest in the association between difficulties in reading, spelling, and handwriting (Alamargot et al., 2020; Arfé et al., 2020; Barnett et al., 2019; Prunty & Barnett, 2017). In recent years, a handful of Malaysian studies have increasingly emphasised the role of alphabetic/phonological awareness, grapheme-phoneme correspondence, and word recognition in Malay and English among young learners (Jamaludin et al., 2015; Lee, 2019; Lee & Wheldall, 2011; Wang & Lee, 2020). Hitherto, there is still a dearth of research on the relationship between reading, spelling, and handwriting in both Malay and English in the Malaysian context.

In a multi-ethnic and multicultural country like Malaysia, Malay (the Standard Malay, known as *Bahasa Melayu*) and English are the two main spoken and written languages besides Mandarin, Tamil, and other local dialects making Malaysia a multilingual nation (Lee et al., 2020). The aspiration for Malaysia, as documented in the Malaysian Education Blueprint, is for every child to be proficient in both Malay and English at the end of secondary school education (Ministry of Education Malaysia, 2013). Thus, both languages are taught in school. For instance, a student's first language may be Mandarin, but he/she would simultaneously receive formal instruction in Malay (the national language) and English in school. Given the emphasis on bilingual proficiency among Malaysian students, the use of both Malay and English is an important research focus. To date, the focus of most studies on literacy development and specific learning difficulties is on monolingual speakers (e.g., Alamargot et al., 2020; Arfé et al., 2020; Lee & Al Otaiba, 2017; Lonigan et al., 2013; Prunty & Barnett, 2017; Puranik & Al Otaiba, 2012; Shaywitz & Shaywitz, 2020; Snowling et al., 2019). However, there has been a surge of interest in the reading acquisition and

language development in both English and Malay among young multilingual learners (Jamaludin et al., 2015; Lim et al., 2015; Lee et al., 2019; Lee et al., 2020; Lee & Wheldall, 2011; Rickard Liow & L. C. Lee, 2004; Wang & Lee, 2020; Winskel, 2020).

In sum, at the heart of this issue is the need to consider appropriate identification of reading difficulties among young multilingual learners. The prevalence of students with reading difficulties, comorbidities between the difficulties in reading, spelling, and handwriting as well as the dearth of research in these three fundamental skills combined, within the multilingual context, have demonstrated the need of further investigation on the relationship of reading, spelling, and handwriting in literacy development.

1.3 Research Objectives

The objectives of this study are to:

- i. investigate whether there is any significant correlation between handwriting quality, reading in Malay, and spelling in Malay.
- ii. investigate whether poor readers in Malay are also poor in handwriting.
- iii. investigate whether poor readers in Malay are also poor spellers in Malay.
- iv. investigate whether there is any significant correlation between handwriting quality, reading in English, and spelling in English.
- v. investigate whether poor readers in English are also poor in handwriting.
- vi. investigate whether poor readers in English are also poor spellers in English.
- vii. investigate whether poor readers in Malay are also poor readers in English.
- viii. investigate whether poor spellers in Malay are also poor spellers in English.

1.4 Research Questions

The research questions of this study are:

- i. Is there any significant correlation between handwriting quality, reading in Malay, and spelling in Malay?
- ii. Are poor readers in Malay also poor in handwriting?
- iii. Are poor readers in Malay also poor spellers in Malay?
- iv. Is there any significant correlation between handwriting quality, English reading in English, and spelling in English?
- v. Are poor readers in English also poor in handwriting?
- vi. Are poor readers in English also poor spellers in English?
- vii. Are poor readers in Malay also poor readers in English?
- viii. Are poor spellers in Malay also poor spellers in English?

1.5 Significance of The Study

It is crucial to understand the relationship of handwriting, spelling and word reading accuracy among multilingual Primary 1 poor readers. As there is a growing interest in the field of reading, spelling, and handwriting, it is anticipated that this study can contribute to the extant literature. The already mounting evidence that alphabetic knowledge and phonological awareness are strong predictors of reading ability and RD (NELP, 2008; Shanahan & Lonigan, 2013), often deflect the necessity to use other indicators such as handwriting and spelling for detecting reading disability among young learners. Thus, this study may offer important practical implications for policymakers, practitioners, teachers,

and parents if more literacy components such as handwriting and spelling can be applied as indicators for the early identification of RD, especially among multilingual learners.

1.6 Conceptual Framework

The conceptual framework of this study is presented in Figure 1.1. Based on the performances in reading, handwriting, and spelling, A standard cut-off point of the 25th percentile and below was introduced to operationalise deficits in reading (See Section 1.7.5). The reading skill was assessed using the word reading accuracy (WRA) test; the handwriting quality was determined using name writing and letter writing tests; and spelling performance was determined using spelling test.

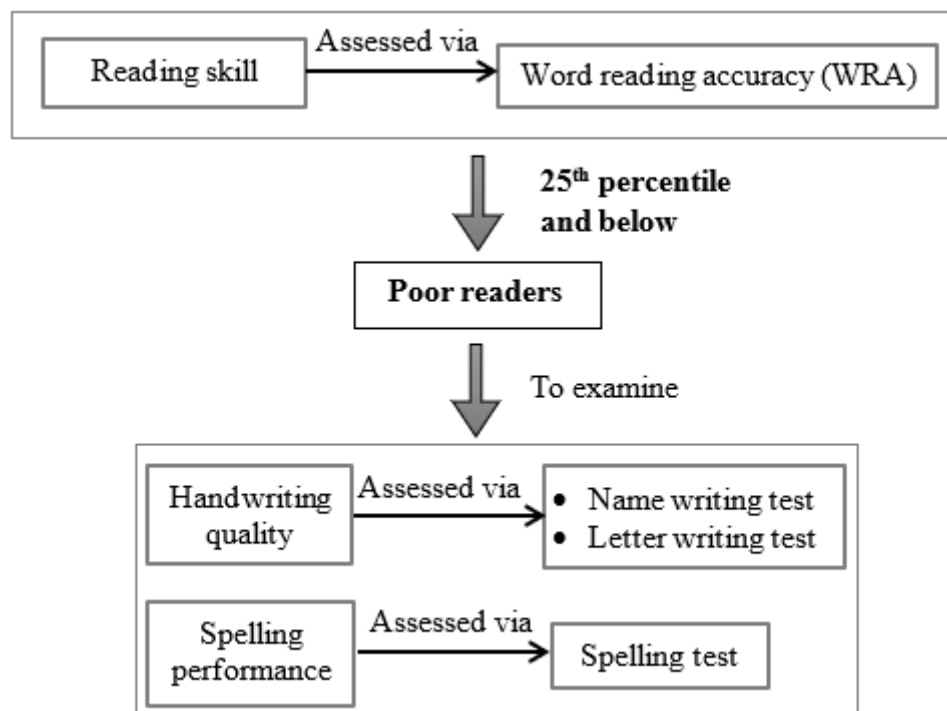


Figure 1.1: Conceptual Framework of the Study

1.7 Conceptual and Operational Definitions

1.7.1 Handwriting

Handwriting is one of the building blocks of writing (Limpo & Graham, 2020). It is a complex neuromotor skill that involves numerous incorporations of the cognitive and motor processes of the writer (Horowitz, 2018; Limpo & Graham, 2020; van der Meer & van der Weel, 2017).

In this study, handwriting was operationalised based on name writing and letter writing tests. The name writing test was used to evaluate the students' ability to write their names and was scored according to the letter formation, spacing, capitalisation, reversal, and spelling mistakes. Meanwhile, the letter writing test was used to evaluate the students' ability to write correct capital and small letters with appropriate letter formation.

1.7.2 Spelling

Spelling is a process of encoding phonemes into graphemes (Puranik et al., 2011; Sayeski et al., 2019). In this study, a spelling test (i.e., phonological coding) was used to evaluate the student's ability to spell the words that were verbalised by the test administrator. The spelling test was group-administered (Lee et al., 2020). The students were asked to spell 10 words each in Malay and English.

1.7.3 Word Reading Accuracy

Word reading accuracy was used in the current study to measure the reading skill (decoding) because word reading is aligned to the developmental time-point of Primary 1 children who were learning how to read words. Furthermore, the words used in the reading assessments have been taught to the beginning readers in the schools and the children are

familiar with word reading (Nation, 2019). Furthermore, the ability to decode is emphasised during early reading (Vaughn et al., 2019).

In this study, the word reading accuracy (WRA) test assessed the student's ability to read 10 single words each in Malay and English accurately. The WRA test was administered individually using the same words from the spelling test.

1.7.4 Multilingual

The conceptual definition of multilingual in this study referred to individuals who can speak their native language at home, their national language at school as well as acquire at least a foreign language (Duka & Aziz, 2019).

Multilingual was then operationalised by categorising students from different ethnic backgrounds, who have been receiving formal language instructions in Malay and English in schools and could speak in their first language (i.e., mother tongue).

1.7.5 Poor Readers

The conceptual definition of poor readers in this study was students who could not read Malay and English word accurately. In this study, a standard cut-off point of the 25th percentile and below was applied to operationalise poor readers. Numerous studies have applied a cut-off point of the 25th percentile and below to determine the presence of deficits across measures (Germano et al., 2017; Lee et al., 2020; Macaruso & Rodman, 2011; Snellings et al., 2009; Stanovich & Siegel, 1994).

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, the bilingual proficiency in Malay and English; the orthographic depths of Malay and English languages; the literacy development of reading, spelling, and handwriting; the relationship between reading, spelling and handwriting; reading, spelling and handwriting difficulties; and theoretical framework were elaborated.

2.2 Bilingual Proficiency in Malay and English

Growing up in a post-colonial and multi-ethnic nation like Malaysia, learning to speak more than one language is a norm for the people. Students may speak their native language at home, and national language at school as well as acquire at least a foreign language (Duka & Aziz, 2019). Learning to read in any language involves the process of matching grapheme on the page to the phonology of the spoken language (Winskel, 2020). Therefore, it is important to consider that different languages have different writing system and varies in their respective orthographic depths (Borleffs et al., 2019). Children who grow up in a multilingual context may face challenges as they learn languages and scripts that possess unrelated and distinctive characteristics, thus limiting the transferability of reading-related skills (Winskel, 2020).

In Malaysia, learning the English language involves multiple factors. On the Malaysian states of the island of Borneo, where the largest indigenous group is Iban, learning English is less straightforward than Iban and Malay languages as reported in a case study by Duka and Aziz (2019). Duka and Aziz (2019) reported that the learners' acquisition of English as a second language was influenced by multilingualism along with their home

learning support, perception towards the language and motivation in learning it. In another study by Lee and colleagues (2019), phoneme-grapheme connections in Malay word building among Malay-English bilingual Grade 2 Malaysian students (mean age = 8.01 - 8.07) were examined; high-performing students ($n = 32$) significantly utilised more syllabic and multi-letter chunks to build non-words. Contrarily, the low-performing students ($n = 24$) significantly applied more letter-by-letter strategy to build non-words, and the error patterns made indicate that their partial alphabetic knowledge was limited (Lee et al., 2019). It was concluded that the transparency of the writing system may facilitate less skilled readers to advance into the consolidated alphabetic phase during word building (L.W. Lee et al., 2019).

In a review by Winskel (2020) on phonological awareness and reading in unilingual and bilingual/multilingual contexts, specifically in the three main languages of Malaysia (i.e., Malay, Tamil and Chinese), learning to read in the second language would be easier if the orthography of the children's first language and their second language were similar. In sum, multilingualism can influence the language acquisition of the learner (Duka & Aziz, 2019). It is also vital to consider the orthographic depth of the language as it may impact the process of learning the respective language.

2.3 Orthographic Depth

The variability in the orthographic depth of a language influences the way learners understand the sound structures of the language (Borleffs et al., 2019). Orthographies are positioned on a continuum, depending on the grapheme-phoneme mapping consistency (Dixon et al., 2010). A shallow orthography means that there is a clear and predictable mapping between grapheme and phoneme (one-to-one grapheme-phoneme correspondence). For example, in Malay, the 'a' (/ʌ/) in *abang* (brother), *makan* (eat), and

mana (where) are consistent. Conversely, grapheme-phoneme correspondence is more complex in a deep orthography where the same graphemes represent different sounds across different contexts (Yap et al., 2010). For example, in English, the ‘a’ in ‘about’ is a schwa (with /ə/ sound), while the ‘a’ in ‘make’ is a long ‘a’ (with /ā/ sound) and is a short ‘a’ (with /æ/ sound) in ‘cat’.

In Malaysia, proficiency in both Malay and English is highly emphasised in the Malaysian education system (Ministry of Education Malaysia, 2013). These two languages possess distinct writing systems and orthographic depths (Aziz et al., 2020; Borleffs et al., 2019; Lee & Wheldall, 2011). Given that Malay and English have the same alphabetic script, children whose first language was Malay and who subsequently learned English as their second language were said to be more likely to experience the beneficial transference of language processing skills than children whose first and second languages and orthographies were unrelated (Winskel, 2020).

2.3.1 The Orthographic Depth of the Malay Language

Malay is a romanised writing system known as Rumi, which is based on the Latin script comprising the same 26 letters in the English alphabet (Lee, 2008). Malay is a shallow orthography for its simple syllable structures and transparent affixation (Yap et al., 2010). Lee and Wheldall (2011) explained that there are 34 graphemes in the Malay orthography, which comprise 26 letters of the alphabet, three diphthongs (*au*, *ai*, and *oi*) and five diagraphs (*gh*, *kh*, *ng*, *ny* and *sy*), except for the letter ‘e’ that carries two vowel sounds, for instance, /e/ as in *ekor* (tail) and /ə/ as in *emak* (mother). Malay words also have simple syllable structures, but different degrees of phonic structures (Aziz et al., 2020). For instance, *bapa* (father) has both simple syllable and phonic structure (CV+CV); *perangai* (behaviour) has

a simple syllable structure but a more multifaceted phonic structure (CV+CV+CV with digraph and diphthongs). Additionally, longer words with more complex syllable structures have CVC or VC syllables such as *mesyuarat* (meeting; CVC+CV+V+CVC) and *berlian* (diamond; CVC+CV+VC). There are also loanwords with phonic structures like CCV such as *graf* (graph) and *teleskop* (telescope).

2.3.2 The Orthographic Depth of the English Language

English is a deep orthography because its grapheme-phoneme correspondence is not one-to-one (Larsen et al., 2020). Being the least consistent among Indo-European languages (Borleffs et al., 2019), English has an extensive number of phonological variations characterised by its morphological variations (Frost, 2012). The English orthography has evolved into a highly inconsistent writing system due to the changes in pronunciation, which is affected by various features such as derivations and inflexions, the addition of suffixes, and changes in stress due to affixation (Frost, 2012). Some graphemes can represent different phonemes during reading (e.g., ‘oo’ is pronounced as /ʊ/ in ‘nook’, but /u:/ in ‘noon’) and some phonemes can be represented by different graphemes during spelling (e.g., /i/ in ‘see’ and ‘sea’; Larsen et al., 2020).

Overall, Malay is a more consistent language compared to English due to its close-to-perfect grapheme-phoneme correspondences (Ng & Yeo, 2013; Yap et al., 2010). A deep orthography like English often hinders accurate pronunciation unless the word is registered in the reader’s vocabulary (Borleffs et al., 2019). Thus, literacy acquisition can be affected by different consistency and regularity in grapheme-phoneme correspondences displayed across different orthographies influence (Ng & Yeo, 2013).

2.4 Literacy Development: Reading, Spelling, and Handwriting

2.4.1 Reading

Alphabetic knowledge and phonological awareness have been identified as fundamental literacy skills in early reading development (NELP, 2008). Reading is a cognitive process that involves the decoding of graphemes (symbols or letters in print) into phonemes (smallest unit of sounds; Julius et al., 2016). Ehri and McCormick (1998) introduced five phases of word learning (i.e., pre-alphabetic, partial alphabetic, full alphabetic, consolidated alphabetic, and automatic alphabetic), where the course of word reading was distinguished based on students' working knowledge of the alphabetic system. Subsequently, when a child has learned to decode rapidly, the final goal of learning to read is comprehension (Lohvansuu et al., 2021).

2.4.2 Spelling

Spelling is described as a developmental process that acts as one of the earliest indicators of literacy skills (Ritchey et al., 2010). Research on spelling development in the alphabetic writing system (Treiman, 2017), suggests that spelling involves the process of encoding phonemes into graphemes (Puranik et al., 2011; Sayeski et al., 2019). The spelling development of a child begins with early scribbles and transitions into prephonological spelling involving letters; then it proceeds to phonologically influence invented spelling, and more advanced spelling (Treiman, 2017a). Treiman (2017b), who used the dual-route framework to describe the two ways of spelling a word suggest that the first method – the lexical route, is where the spelling of the word is looked up in one's mental lexicon. Being able to look up in one's mental lexicon results from previously encountered spellings during reading or other activities that have been memorised as wholes and stored in the long-term

memory. The second method – the nonlexical route, is where spelling is generated based on the rules of phoneme-grapheme mapping (Treiman, 2017b).

2.4.3 Handwriting

Handwriting is the act of writing graphical marks by hand that communicate the information based on the syntactic and semantic specific rules of a specific language (Campisi et al., 2011). Handwriting is also a complex neuromotor skill that involves numerous incorporations of the cognitive and motor processes of the writer (Horowitz, 2018; Limpo & Graham, 2020; van der Meer & van der Weel, 2017). The practice of handwriting facilitates children's literacy and cognitive development (Marquardt et al., 2016). The implications of handwriting in literacy development have been emphasised by many researchers over the years (James, 2017; James & Engelhardt, 2012; McCarney et al., 2013; Reutzel et al., 2019). Despite the digitalisation of classroom instruction, such as keyboard instruction, it can be detrimental to children's literacy acquisition if handwriting instruction is completely replaced by keyboarding instruction as keyboarding reduces children's ability to recognise letters (MacKenzie, 2019). Berninger et al. (2018) argued that literacy learning does not only involve auditory and visual inputs (i.e., *language by ear* and *language by eye*) but the verbal and graphomotor outputs (i.e., *language by mouth* and *language by hand*) as well.

Notably, children who have practised handwriting excel in reading and spelling because practising handwriting while learning sounds can promote literacy as the reading circuits in the brain are activated (Horowitz, 2018). It demands neural resources to analyse received stimulus, for example, visual feedback when viewing or copying written words; and auditory processing when words are dictated (Longcamp et al., 2016), which means that

handwriting links visual processing with motor experience and facilitates subsequent letter recognition skills (James, 2017). These brain connections, however, can only occur when children are engaged in handwriting activities (i.e., writing letters or words independently), not when tracing or typing letters (James & Berninger, 2019). In sum, researchers have continuously acknowledged the importance of handwriting in literacy acquisition in past studies (Graham et al., 2000; Pritchard et al., 2020; Puranik et al., 2011; van Galen, 1991). Despite technological advancements, handwriting is still a developmental foundation that facilitates communication via written language (Fears & Lockman, 2018).

2.5 The Relationship Between Reading, Spelling and Handwriting

2.5.1 Reading and Spelling

The grapheme-phoneme correspondences between reading and spelling are closely related, involving the mapping of letters to sounds for reading and vice versa for spelling (van Witteloostuijn et al., 2021). Research has suggested that reading and spelling are consistently correlated (Y. Kim et al., 2018). These skills have been described as “two sides of a coin” by Ehri (2000, p. 19) because both rely on alphabetic knowledge and working memory that develop concurrently. Besides letter-writing fluency and word-and syntax-level oral language skills, reading and spelling are important componential skills in beginning writing (Y. Kim et al., 2011). Hence, reading and spelling are two skills that work together and are equally essential in the literacy development of school-going children.

2.5.2 Reading and Handwriting

Handwriting acquisition is an important factor that contributes to literacy development (Marquardt et al., 2016). Educational neuroscience researchers have repeatedly emphasised that handwriting experience is vital in the formation of the brain network that

facilitates letter recognition because handwriting and letter perception recruit the same network of activation in the literate brain (James, 2017; James & Berninger, 2019). The formation of letters stroke by stroke enables students to hold formed letters in the “mind eyes” in their memory, which permits the execution of letter writing from their memory and improves word reading as well (Berninger, 2009, p. 73). McCarroll and Fletcher (2017) reported that there is a connection between handwriting and reading scores; and that a stronger connection between handwriting scores and writing exists. Other studies reported that preschool children who learned to write letters by hand were better at letter recognition compared to those who wrote on the keyboard (Longcamp et al., 2005). These studies demonstrated the important relationship between handwriting and reading.

On the contrary, Prunty and Barnett (2017) recruited twenty-eight students aged 8 to 14 years for their study and found no significant relationships between any of the literacy measures (i.e., vocabulary, reading, spelling, and manual dexterity) and the handwriting measures (i.e., quality of letter formation, handwriting speed, legibility, execution speed, and pausing) among students of the same age group. Nonetheless, there was a significant relationship between spelling, vocabulary, and manual dexterity with some of the handwriting measures when all the students – all age groups combined, were measured together (Prunty & Barnett, 2017). Therefore, reading and handwriting are fundamentally crucial in literacy development. Learning to write facilitates the process of learning to read (Berninger et al., 2018). Both skills are required simultaneously as they have an impact on academic performance.

2.5.3 Handwriting and Spelling

Handwriting and spelling are transcription skills. Collectively, they are considered the writing components according to the simple view of writing (Berninger et al., 2002). Transcription skills are among the essential components of writing skills that can impact early writers' success (Y. Kim et al., 2013; Puranik & Al Otaiba, 2012; Rodríguez & Villarroel, 2017; Wanzek et al., 2017). Although producing a written trace is the primary function of handwriting, it also interacts with orthographic processing – spelling and grammar (Alamargot et al., 2020). Berninger and colleagues (2002) described writing as *language by hand* that shares common processes with reading (*language by eye*), listening (*language by ear*) and speaking (*language by mouth*). The integration of good motor skills, letter knowledge and orthographic knowledge is necessary for text production on paper (Puranik & Al Otaiba, 2012).

Handwriting encompasses two aspects, namely fluency – the ability to write easily at speed; and legibility – the ability to write clearly (Caravolas et al., 2020). To produce letters, words, and sentences by hand, one needs to articulate the motor demands of handwriting with the orthographic information on letter sequencing (Limpo & Graham, 2020). A study by Pontart and colleagues (2013) revealed that the handwriting and spelling performances of students in the primary grades were influenced by the graphomotor program and orthographic knowledge, whereas students in the lower secondary grades were only affected by orthographic knowledge. It was the lack of graphomotor automatisation and the inefficiency of alphabetic letter retrieval that made it difficult to maintain the orthographic form during its execution and increased handwriting duration to allow the reiteration of central processing of spelling when storage failure occurred (Pontart et al., 2013).

Many studies have demonstrated that the mastery of handwriting skills and spelling is positively correlated (Alamargot et al., 2020; Lichtsteiner et al., 2018; Pritchard et al., 2020; Ritchey, 2008). Due to the integration of the motor aspects of handwriting and the perceptual aspects of alphabetic knowledge that are necessary for letter writing, name-writing, and letter-writing skills uniquely facilitate students' spelling ability (Puranik et al., 2011). In sum, efficient handwriting and spelling skills are correspondingly necessary for the writing process (Graham et al., 2017).

2.6 Reading and Transcription Difficulties

2.6.1 Reading Difficulties

Reading difficulties (RD) are typically characterised by one's inability in learning to read (Grigorenko et al., 2020), which entails difficulties to decode and spell fluently (Snowling et al., 2020). RD is also operationalised as an unexpected disability in learning to read because the difficulties in reading and writing manifest despite adequate cognitive capacity and instructional or environmental opportunities, and is not prompted by impaired sensory, lack of motivation, emotional instabilities, or any other possible extraneous factors (Shaywitz & Shaywitz, 2020). A highly intelligent person may unexpectedly read at a below-average level even though he/she is expected to read well or above-average level, if his/her education, intelligence, or professional status were taken into consideration (Shaywitz & Shaywitz, 2020).

As reading development begins with learning the mappings between graphemes and phonemes, students who master alphabetic principles can decode words effortlessly and acquire orthographic knowledge of how the written language works (Snowling et al., 2020). Contrarily, students with RD manifest specific difficulties in phonological decoding and

emergent reading skills from early preschool, years before any reading instruction (Snowling et al., 2019; Torre & McKay, 2020). Eventually, they struggle with automatic word decoding and reading fluency, which leads to inefficient word recognition, making learning to read laborious (Snowling et al., 2020).

2.6.2 Transcription Difficulties

Transcription difficulties, which are associated with specific learning difficulties, are characterised as poor handwriting skills or poor spelling skills, or both poor handwriting and spelling skills (Berninger, 2007). Inaccurate letter formations, inconsistent sizing of letters, decreased alignment of the letters to the line, and limited spacing between and within words are some of the possible symptoms of poor handwriting reported by teachers (Fancher et al., 2018). Individuals with poor handwriting skills usually struggle to produce legible written letters/words fluently (Alamargot et al., 2020), and often have poor performance in phonological processing skills (i.e., phonological awareness and phonological working memory; Döhla et al., 2018). Researchers have emphasised that appropriately legible and automated handwriting is crucial in the acquisition of higher-order skills such as spelling and story composition (Gargot et al., 2020). In most cases, individuals with poor handwriting have reduced working memory capacity as they expand their cognitive ability to recall the spelling of the words and the mechanics of producing written words (McCarney et al., 2013). Subsequently, a certain level of automaticity cannot be achieved due to the significantly longer time taken and the unlikelihood to produce correctly spelt and legibly written words (McCarney et al., 2013). Inefficient handwriting consumes cognitive resources at the expense of orthographic processing (Alamargot et al., 2020).

2.6.3 Co-occurring Difficulties in Reading and Transcription

Reading difficulties (RD) are commonly associated with transcription (handwriting and spelling) difficulties, but the nature of their association remains unclear, and the vast existing research on handwriting and spelling performances of students with RD is on deep orthographies, mainly in the English-speaking contexts (Arfé et al., 2020). RD can occur in isolation and co-occur with other neurodevelopmental disorders at a frequent rate, which indicates high chances of comorbidities (Moll et al., 2020). Some students with transcription difficulties have been reported to also experience RD while some students do not (Berninger, 2007; Di Brina et al., 2018; Prunty & Barnett; 2017). The high chance of comorbidity between RD and handwriting difficulties suggests that transcription difficulties are common among students with RD (Ashraf & Najam, 2020; Moll et al., 2020; Sumner et al., 2014).

Automatic letter writing and letter naming are common problems faced by students with RD as these difficulties are related to impaired inhibition and verbal fluency, which may explain their spelling problems (Berninger et al., 2008). Furthermore, students with RD who struggle in writing, often experience poorer writing outcomes because extensive working memory is required; when a writer has poor spelling skills, the working memory resources that are required for idea generation throughout the writing process are constrained (Hebert et al., 2018). During the writing process, the cognitive demand for spelling is manifested when it forces the writer to pause frequently within words (Sumner et al., 2014), which results in producing less fluent and legible handwriting. Academically, students with poor handwriting are inclined to have lower scores in reading and spelling assessments, besides having lower IQ, and reduced working memory capacity (McCarney et al., 2013). A longitudinal study by Costa et al. (2016) has also revealed that students with reading and writing difficulties experienced an increased cognitive burden in language and executive

dysfunctions from grade one through grade four. It was also discovered that the co-occurrence of reading and writing difficulties increased from 30% during grade one to 47% by grade four (Costa et al., 2016).

In addition, the required tasks in reading and spelling assessments encompass memorising and producing different shapes of alphabet letters, grapheme-phoneme correspondence during the composition of words as well as holding the pen/pencil correctly and manipulating it to produce the required lines/curves (McCarney et al., 2013). Therefore, McCarney et al. (2013) suggest that reading and spelling scores are the only measures that distinguish between poor and very poor hand-writers because all the required tasks in the reading and spelling assessments place a demand on working memory until they become automated. Students who encounter challenges with handwriting automatisisation often struggle to keep up with the rising cognitive demands of schoolwork, which in turn cause immense exhaustion and decline in cognitive performance (Gargot et al., 2020). Considering that reading and writing tasks are academic pursuits that are inevitable for students, it is crucial to identify the symptoms of these difficulties for the optimal implementation of early intervention.

2.7 Theoretical Framework of the Present Study

Researchers suggested that both decoding and (listening) comprehension are necessary for reading success in the Simple View of Reading (Gough & Tunmer, 1986). Decoding exerts a larger impact on comprehension at lower grades where the text demand is still relatively simple compared to later grades, thus the ability to decode is emphasised during early reading (Vaughn et al., 2019). Even though it is necessary to operationalise and measure decoding as the fluency and expertise of a skilled reader, this operationalisation is

however, inappropriate for children who are still learning to read, whose word recognition and word reading are not fluent yet and still lacks expertise (Nation, 2019). Hence, word reading accuracy was used in the current study to measure the reading skill (decoding), where the appropriate developmental time-point is reflected, and the words used in reading are familiar to the children (Nation, 2019). Subsequently, when a child learns to read, learning to spell also develops. The “two sides of a coin” theory on reading and spelling (Ehri, 2000, p. 19), helps researchers to understand that the grapheme-phoneme correspondence of reading and spelling is one-to-one in most of the alphabetic languages.

On the other hand, writing is described by Berninger and colleagues (2002) as *language by hand* that shares some common processes with other kinds of language – *language by eye* (reading), *language by ear* (listening) and *language by mouth* (speaking). Thus, writing involves distinct processes that are exclusive to writing and not merely motor or visual activity (Berninger et al., 2006; Berninger et al., 2018). The simple view of writing introduced by Berninger et al. (2002), as shown in Figure 2.1, is represented by a triangle, where text generation (the top vertex) is supported by writing components represented by two vertices at the base of the triangle: (a) transcription skills (i.e., spelling, handwriting, and keyboarding); and (b) executive function skills (i.e., conscious attention, planning, reviewing, revising, and strategies for self-regulation). Additionally, due to the complexity of writing, working memory is represented at the centre of the triangle to illustrate its constraint towards these skills because fewer resources are available to manage other components of writing tasks when working memory resources are needed for any individual component of the process (Berninger et al., 2002).

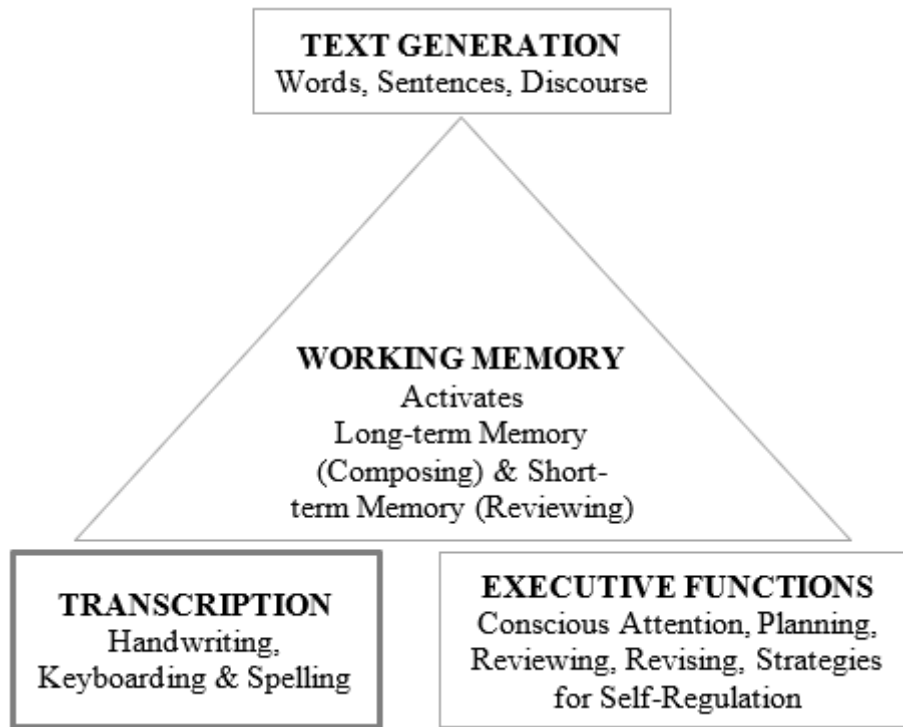


Figure 2.1: Simple View of Writing (Berninger et al., 2002)

The key tenet of this model was applied in this study to explain the crucial skills that are required in decoding (word reading) and text generation. Word reading accuracy and transcription skills (i.e., handwriting and spelling) were highlighted in this study. Students with poor handwriting have lower working memory scores as they expand their cognitive ability to recall the spelling of the words and the mechanics of producing the written words; the constricted working memory inhibits the level of automaticity because significantly longer time is taken spell words. Furthermore, these students face the likelihood of producing incorrectly spelt and illegibly written words (McCarney et al., 2013). Therefore, based on the Simple View of Reading (Gough & Tunmer, 1986), the “two sides of a coin” theory on reading and spelling (Ehri, 2000, p. 19), the writing process as *language by hand* (Berninger et al., 2018), and the simple view of writing on the concept of transcription skills (Berninger et al., 2002), if one is unable to spell correctly and write legibly, it is likely that one’s reading ability might also be impacted.

In sum, this chapter has elaborated on how Malay and English differ in their orthographic depths and the bilingual proficiency of Malaysian students in both languages. This information provides more insights to understand the influence of languages in students' reading and spelling skills in research question 7 and 8. The elaboration of the relationship between reading, spelling and handwriting along with the respective difficulties in each skill as well as the theoretical framework were also included in this chapter. These explanations are crucial for answering the degree of association between these skills in Malay and English respectively in research question 1 to 6.

CHAPTER 3

METHODOLOGY

3.1 Background of the Larger Study

This study was drawn from a larger study on the development of an early reading assessment battery for multi-ethnic and multilingual learners in Malaysia (Lee et al., 2020; see also Tang et al., 2018). A sample of 866 Primary 1 students (47% females, 53% males; age range = 6.61-7.82, M age = 7.13, SD = 0.29) were randomly selected from 11 government primary schools in Kuching, Sarawak, Malaysia. The ethnic backgrounds were as follows: Malay (67.1%), Iban (13.9%), Bidayuh (8.3%), Chinese (3.1%), and others (5.9%), which included the other minority indigenous peoples of Sarawak such as the Kayan, Kelabit, Melanau, Murut, and Penan. Missing data was 1.7%. Only students with parents' consent were included in the study.

In order to understand students' multilingual profiles, the data on the first, second and third languages used by the students were also collected. The most widely spoken first language was Sarawak Malay (n = 563) of which Malay participants were the major users. Sarawak Malay is a dominant local dialect that serves as Sarawak's major lingua franca (McLellan, 2014). The first languages of other participants comprised Iban (n = 119), Malay language (n = 69), Bidayuh (n = 51), and Chinese (n = 18) (Lee et al., 2020). Besides that, the most spoken second language was the Malay language (n = 748), followed by English (n = 81) and Sarawak Malay (n = 15). Lastly, the most widely spoken third language was English (n = 745), followed by the Malay language (n = 34) and Sarawak Malay (n = 15).

3.2 Measures

The students' handwriting quality was assessed using name and letter writing (capital and small letters) tests; meanwhile, their reading and spelling abilities were investigated using word reading accuracy (WRA) and spelling test, respectively.

3.2.1 Name Writing

For the name writing task, the students were asked to write their full names on lined paper (See Appendix A for the sample instrument). The names written were then scored between a range of 0 and 4 based on Jee and Lee's (2014) rubrics on letter formation quality, spacing, capitalisation, letter reversals and/or spelling mistakes (see Appendix I).

3.2.2 Letter Writing

The letter writing task comprised capital letters and small letters (See Appendix B and C for the sample instruments). The students were requested to write 26 dictated letters individually in random order on lined paper. The capital letters were dictated first before the small letters. The letters written were then scored between a range of 0 and 2 based on Jee and Lee's (2014) rubrics on the correct letter written and letter formation quality (see Appendix I). The outcome of letter writing (i.e., capital letters and small letters) ranged between 0 and 52.

3.2.3 Spelling

The spelling test assessed the students' ability to spell the words that were verbalised to them by a test administrator (See Appendix D and E for the sample instrument). There was a list of 10 words each in Malay and English. The Malay words were selected from the Primary 1 Malay textbook (Abdul Hadi et al., 2010, 2012): *susu* (milk), *gula* (sugar), *kerusi*

(chair), *epal* (apple), *penyu* (turtle), *Isnin* (Monday), *menyiram* (watering), *terjatuh* (fell), *berhati-hati* (be careful), and *buah-buahan* (fruits). Meanwhile, the English words were selected from the Primary 1 English textbook (Zainuddin & Ahamad, 2011): *pretty*, *sick*, *thick*, *your*, *shark*, *shoulder*, *elephant*, *name*, *them*, and *want*.

The spelling outcomes were then coded using the phonological coding (PC) system on a 7-point scale (see Appendix I; Tangel & Blachman, 1992; see also Lee & Al Otaiba, 2017; Tang et al., 2018). The PC system was applied for coding the spelling errors because of its high correlation with phonological awareness abilities and its high sensitivity toward learners' spelling development over time (Ritchey et al., 2010; Tang et al., 2018). The range for the spelling outcome for each language (i.e., Malay or English) was between 0 and 60.

3.2.4 Word Reading Accuracy

The WRA test measured the students' ability to read 10 single real words with no time limit (See Appendix F and G for the sample instruments). The same words from the Malay and English spelling test were used in the WRA test. In the respective language, students scored 1 for each accurately read word and 0 for an inaccurately read word. The range of scores was between 0 and 10.

3.3 Data Collection Procedures

In the larger study, the schools were randomly selected from the Kuching Division, comprising Kuching City North and Kuching City South, for participation in the study. From these schools, all students in Primary 1 were included in the study provided that informed consents were provided by their parents/caregivers. All students were assessed by trained test administrators between August and October in the school year because they were expected to have mastered the Malay and English words used in this study towards the end

of Year 1 after having completed the first half of the school year (see Section 3.3.3). The handwriting and spelling tests were administered in a group of 20 to 30 students while the reading test was individually administered in a designated room at the school premise suggested by the school administrators such as the school library, staff meeting room, or computer room.

3.3.1 Name Writing

In a group of 20 to 30 students, name writing was administered. Students were given a piece of test administration paper to write their names.

3.3.2 Letter Writing

After students had their names written down, administrators proceeded to capital letter writing test, and followed by small letter writing test. The instruction of the tests was explained to the students. Students were asked to write the letters in the spaces provided. If the students could not write the letters after 3 seconds, the subsequent letters would be read. A timer was used to gauge the 3 second-time elapsed.

3.3.3 Spelling

By design, as the same words were used in both spelling and WRA tests, the spelling test was administered prior to the WRA. Assessments for the English language were administered first, followed by assessments for the Malay language on the same day. The students were also assessed in groups of 20 to 30 in vacant classroom during normal school hours. The instruction of the task was described to the students. After that, the research assistant would read out the target word in a short sentence. For example, “Number 1 pretty (pause). That is a pretty dress. Pretty”. 30 seconds were given to the students to write down the word. The same steps were repeated for all the 10 words in Malay and English

respectively. The students were encouraged to spell parts of the words as much as they could even if they were unsure or unable to spell the whole words. Then, the assessment was scored based on PC scoring metrics.

3.3.4 Word Reading Accuracy

The Word Reading Accuracy test was administered to the students individually. Assessments for the English language were administered first, followed by assessments for the Malay language on the same day. The students were instructed to point and read aloud each word on the list. One point was awarded to the students for a correctly read word and the total score were calculated to obtain the total number of words read correctly.

3.4 Operationalisation of Deficits in Reading, Spelling and Handwriting Skills

A standard cut-off point was introduced in this study to operationalise deficits in reading, spelling and handwriting skills. It is important for an arbitrary cut-off to be set on a continuous variable to diagnose a disorder (Peterson & Pennington, 2015). This cut-off point enabled participants who fulfilled the risk criteria to be screened efficiently. Numerous studies have applied a cut-off point of below the 25th percentile to determine the presence of deficits across measures (Germano et al., 2017; Lee et al., 2020; Macaruso & Rodman, 2011; Snellings et al., 2009; Stanovich & Siegel, 1994). Apart from that, the terms “good” and “poor” were used for the categorisation (Catts et al., 2003; Lee & Al Otaiba, 2017; Russak & Kahn-Horwitz, 2015). Students who were categorised as at-risk for reading, spelling, and handwriting skills were coded as “0” (poor) and those who were not at-risk for the same skills were coded as “1” (good).

3.5 Data Analysis

The Statistical Package for Social Science (SPSS) Version 26 was used for the data analysis. After data collection was completed, all the data were gathered from respective research assistants and were compute in the SPSS. After that, data screening and cleaning, validity, and reliability of research instruments, and both descriptive and inferential analyses were conducted.

3.5.1 Data Screening

Data screening is necessary to check for errors in the data set before data analysis. To ensure that the scores are within the minimum and maximum scoring range before calculating the total scores, each item of name writing and letter writing, spelling outcomes and WRA were screened. Additionally, the valid and missing data, as well as outliers of each variable, were also screened. Missing data were coded as “999”. Little’s Missing Completely at Random (MCAR; Little, 1998) test was conducted to determine if the data were MCAR.

3.5.2 Validity and Reliability of the Research Instruments

3.5.2.1 Validity

Convergent validity was used to observe the correlations between the scores for reading, spelling and handwriting performances in Malay and English.

3.5.2.2 Reliability

Kuder-Richardson formula 20 was performed to determine the interrater reliability of the items across name writing, capital and small letter writing tests as well as spelling tests in both languages. Additionally, test-retest reliability was used to determine the students' consistency in the untimed measure, specifically the WRA in both languages.

3.5.3 Descriptive Analysis

Descriptive analysis was conducted on students' handwriting quality, reading, and spelling performances in Malay and English.

3.5.4 Inferential Analysis

The inferential analysis tests used in this study were Pearson correlation coefficient analysis and McNemar's test.

3.5.4.1 Pearson Correlation Coefficient Analysis

Pearson correlation coefficient is used to reflect the linear correlation of two normal continuous variables (Xu & Deng, 2017). In this study, the Pearson correlation coefficient analysis was conducted to investigate the relationship between handwriting quality, reading and spelling performances in Malay and English, respectively. The strength of correlation (i.e., small, medium and large) was determined by using a guideline suggested by Cohen (1988), with a specific range of positive correlation coefficient, r (small correlation, $r = 0.10$ to 0.29 ; medium correlation, $r = 0.30$ to 0.49 ; large correlation, $r = 0.50$ to 1.00) as well as negative correlation coefficient (small correlation, $r = -0.10$ to -0.29 ; medium correlation, $r = -0.30$ to -0.49 ; large correlation, $r = -0.50$ to -1.00).

3.5.4.2 McNemar's Test

McNemar's test is an exploratory tool for analysing pre-post differences in paired dichotomous data and testing the significance of changes in related proportions (Adedokun & Burgess, 2012; Lachenbruch, 2014). McNemar's test is more appropriate for analysing paired binomial data that use a 2×2 contingency table compared to the chi-squared test, even though the latter is more common than the former (S. Kim & W. Lee, 2017; Pembury Smith & Ruxton, 2020). In this study, the scores across measures were recoded into

dichotomous values (i.e., '0' for poor performance and '1' for good performance) by using the 25th percentile as a cut-off point.

CHAPTER 4

RESULTS

4.1 Data Screening

In this study, missing values were found in the assessments for handwriting quality (0.3% in name writing, capital and small letter writing tests respectively), spelling test (0.2% in Malay and 0.5% in English) and WRA (0.1% in both languages). These missing values were due to students' absenteeism. Little's Missing Completely at Random (MCAR) was tested and was not statistically significant (i.e., $p > .05$), indicating that the missing data were MCAR in the dataset.

4.2 Validity and Reliability Analysis

4.2.1 Validity

All the correlation coefficients across measures for both languages were significant, with r values ranging from .41 to .90 (see Table 1 in Appendix H). The strongest correlation was found between Malay WRA and Malay spelling, $r = .90$.

4.2.2 Reliability

The Cronbach's Alpha value exceeded 0.9 between the interraters for all the items in name writing test, letter writing test and spelling test across both languages (see Table 2 in Appendix H). The test-retest reliability was high in both English WRA ($r = .86$) and Malay WRA ($r = .98$) (see Table 3 in Appendix H; see also Lee et al., 2020).

4.3 Descriptive Statistics

The descriptive statistics of the total dataset ($N = 866$) are presented in Table 4.1.

Table 4.1: Descriptive Statistics of the Total Dataset ($N = 866$)

Measures	Mean	SD	Minimum – Maximum
Name Writing ^a	1.81	1.03	0.00 – 4.00
Capital Letter Writing ^a	29.90	11.39	0.00 – 52.00
Small Letter Writing ^a	32.45	12.38	0.00 – 52.00
English WRA ^c	3.69	3.68	0.00 – 10.00
English Spelling ^b	24.60	16.44	0.00 – 60.00
Malay WRA ^c	7.34	3.61	0.00 – 10.00
Malay Spelling ^d	40.83	18.77	0.00 – 60.00

Note. As a result of missing data, ^a $n = 863$; ^b $n = 862$; ^c $n = 865$; ^d $n = 864$; WRA = word reading accuracy; SD = standard deviation.

4.3.1 Handwriting Quality

The students' handwriting quality was assessed via name writing and letter writing tests. Table 4.1 shows that the small letter writing test yielded the highest mean score and standard deviation, respectively ($M = 32.45$, $SD = 12.38$), followed by capital letter writing test ($M = 29.90$, $SD = 11.39$), and name writing ($M = 1.81$, $SD = 1.03$).

4.3.2 Reading Performance

The reading performance of the students in both languages was assessed using word reading accuracy (WRA). Malay WRA yielded a slightly higher mean score but lower standard deviation ($M = 7.34$, $SD = 3.61$) in comparison to English WRA ($M = 3.69$, $SD = 3.68$). See Table 4.1

4.3.3 Spelling Performance

The spelling performance of the students was measured by using phonological coding (see Table 4.1). The mean score and standard deviation for Malay spelling ($M = 40.83$, $SD = 18.77$) was greater than that of English spelling ($M = 24.60$, $SD = 16.44$).

4.4 Categorisation of Students with Deficits in Reading, Spelling and Handwriting Skills

The students were classified according to the at-risk criterion based on the cut-off point at the 25th percentile (see Table 4.2). At the 25th percentile and below, the percentage of students who performed poorly in the following tests were as follows: name writing test (55.3%), English WRA (33.8%), small letter writing (27.6%), capital letter writing (26.3%), English spelling (26.3%), Malay WRA (25.8%), and Malay spelling (25.5%). In this study, poor readers in Malay ($n = 223$) and in English ($n = 292$) that were focused on research question 1 to 6.

Table 4.2: Poor and Good Outcomes Based on the 25th Percentile Cut-off Criterion

Measures	Poor (25 th Percentile and Below)		Good (Above 25 th Percentile)		Scores at the 25 th Percentile
	<i>n</i>	%	<i>n</i>	%	
Name Writing ^a	477	55.3	386	44.7	1
Capital Letter Writing ^a	227	26.3	636	73.4	22
Small Letter Writing ^a	238	27.6	625	72.4	24
English WRA ^c	292	33.8	573	66.2	0
English Spelling ^b	227	26.3	635	73.7	9
Malay WRA ^c	223	25.8	642	74.2	4
Malay Spelling ^d	220	25.5	644	74.5	27

Note. As a result of missing data, ^a $n = 863$; ^b $n = 862$; ^c $n = 865$; ^d $n = 864$; WRA = word reading accuracy.

4.5 Inferential Statistics

4.5.1 Research Question 1: Is there any significant correlation between handwriting quality, reading in Malay, and spelling in Malay?

All the measures for handwriting quality (i.e., name writing, capital letter writing, and small letter writing), Malay reading (WRA), and Malay spelling performances were

significantly correlated ($r = .41$ to $.90$, $p < .01$, see Table 4.3). The highest correlation was found between Malay WRA and Malay spelling ($r = .90$), and the lowest correlation was found between Malay WRA and name writing ($r = .41$). An asymptotic McNemar's test determined that there was a statistically significant difference between Malay WRA and name writing, $p < .01$. However, an asymptotic McNemar's test determined that no statistically significant difference was found between Malay WRA and capital letter writing, $p = .701$; Malay WRA and small letter writing, $p = .271$; Malay WRA and Malay spelling, $p = .810$ (see Table 4.4).

Table 4.3: Correlations of Measures ($N = 866$)

Measures	1	2	3	4	5	6	7
1. Name Writing	1						
2. Capital Letter Writing	.37**	1					
3. Small Letter Writing	.38**	.83**	1				
4. English Spelling	.46**	.57**	.58**	1			
5. English WRA	.45**	.52**	.51**	.76**	1		
6. Malay Spelling	.45**	.65**	.66**	.80**	.70**	1	
7. Malay WRA	.41**	.59**	.61**	.71**	.65**	.90**	1

Note. WRA = word reading accuracy.

** Correlation is significant at the 0.01 level (2-tailed).

Table 4.4: The Summary of the Statistical Significance between Malay Reading Performance and the Measures for Handwriting Quality and Malay Spelling Performance

Measures	Malay WRA and Name Writing	Malay WRA and Capital Letter Writing	Malay WRA and Small Letter Writing	Malay WRA and Malay Spelling
N	862	862	862	862
Chi-Square ^b	203.521	.147	1.210	.058
Asymp. Sig.	.000	.701	.271	.810

a. McNemar Test

b. Continuity Corrected

Note. WRA = word reading accuracy.

4.5.2 Research Question 2: Are poor readers in Malay also poor in handwriting?

The crosstabulation of poor and good handwriting quality among poor readers in Malay is presented in Table 4.5. Most of the poor readers in Malay were poor in name writing (86%), followed by capital letter writing (62.9%), and small letter writing (61.5%). However, there was a relatively small number of poor readers who had good handwriting quality. Examples of poor and good handwriting quality (i.e., name writing, capital letter writing, and small letter writing) among poor readers in Malay are shown in Appendix J, K, L, M and N.

Table 4.5: Crosstabulation of Handwriting Quality and Spelling Performance Among Poor Readers in Malay

Measures	Poor Readers in Malay			
	Poor		Good	
	<i>n</i>	%	<i>n</i>	%
Name Writing	190	86.0	31	14.0
Capital Letter Writing	139	62.9	82	37.1
Small Letter Writing	136	61.5	85	38.5

Note. As a result of missing data, $n = 221$.

4.5.3 Research Question 3: Are poor readers in Malay also poor spellers in Malay?

The crosstabulation of poor and good Malay spelling performances among poor readers in Malay is presented in Table 4.5. Among the poor readers in Malay, at least 16.2% are good spellers while 83.8% were poor spellers. Thus, the results demonstrate that not all poor readers in Malay were also poor spellers in Malay (see also Appendix O). The following are proportions of poor readers in Malay who could not spell the following words: *buah-buahan* (67.9%), *berhati-hati* (66.1%), *menyiram* (65.6%), *Isnin* (56.1%), *terjatuh* (62.9%), *penyu* (52.9%), *gula* (38.5%), *epal* (36.2%), *kerusi* (35.3%), and *susu* (12.2%). The

examples of poor and good spelling outcomes of poor readers in Malay can be seen in Appendix Q and R respectively.

4.5.4 Research Question 4: Is there any significant correlation between handwriting quality, reading in English, and spelling in English?

All the measures for handwriting quality (i.e., name writing, capital letter writing, and small letter writing), English reading (WRA) and English spelling performances were significantly correlated ($r = .45 - .76$, $p < .01$, see Table 4.3). The highest correlation was found between English WRA and English spelling ($r = .76$), and the lowest correlation was found between English WRA and name writing ($r = .45$). An asymptotic McNemar's test determined that there was a statistically significant difference between English WRA and the measures of handwriting quality and English spelling ($p < .01$; see Table 4.6).

Table 4.6: The Summary of the Statistical Significance between English Reading Performance and the Measures for Handwriting Quality and English Spelling Performance

Measures	English WRA and Name Writing	English WRA and Capital Letter Writing	English WRA and Small Letter Writing	English WRA and English Spelling
N	861	861	861	861
Chi-Square ^b	117.965	19.267	13.770	22.630
Asymp. Sig.	.000	.000	.000	.000

a. McNemar Test

b. Continuity Corrected

Note. WRA = word reading accuracy.

4.5.5 Research Question 5: Are poor readers in English also poor in handwriting?

The crosstabulation of poor and good handwriting quality among poor readers in English is presented in Table 4.7. Most of the poor readers in English were poor in name

writing (82.5%), followed by small letter writing (55.7%), and capital letter writing (53.6%). Conversely, a smaller number of poor readers in English had good handwriting quality. The examples of poor and good handwriting quality (i.e., name writing, capital letter writing, and small letter writing) among poor readers in English are shown in Appendix S, T, U, V, and W.

Table 4.7: Crosstabulation of Handwriting Quality and Spelling Performance Among Poor Readers in English

Measures	Poor Readers In English			
	Poor		Good	
	<i>n</i>	%	<i>n</i>	%
Name Writing	240	82.5	51	17.5
Capital Letter Writing	156	53.6	135	46.4
Small Letter Writing	162	55.7	129	44.3
English Spelling	168	57.7	123	42.3

Note. As a result of missing data, $n = 291$.

4.5.6 Research Question 6: Are poor readers in English also poor spellers in English?

The crosstabulation of poor and good English spelling performances among poor readers in English is presented in Table 4.7. Among the poor readers in English, at least 42.3% are good spellers while 57.7% were poor spellers. Thus, the results demonstrate that not all poor readers in English were also poor spellers in English (see also Appendix X). The following are proportions of poor readers in English who could not spell the words: *want* (76.2%), *shoulder* (70.1%), *shark* (65.3%), *name* (65.3%), *your* (63.2%), *them* (60.8%), *elephant* (60.5%), *thick* (56.4%), *pretty* (50.9%), and *sick* (46.4%). The examples of poor and good spelling outcomes of poor readers in English are presented in Appendix Z and A1 respectively.

4.5.7 Research Question 7: Are poor readers in Malay also poor readers in English?

There was a moderate correlation between Malay and English WRA, $r = .65$ (see Table 4.3). An asymptotic McNemar's test determined that there was a statistically significant difference between Malay and English WRA, $p < .01$. The results demonstrate that not all poor readers in Malay were also poor readers in English. The proportion of poor/good readers ($n = 865$, because of missing data) in Malay and English are as follows: poor readers in both languages (22.5%), poor readers in Malay but good readers in English (3.2%), good readers in Malay but poor readers in English (11.2%), and good readers in both languages (63%).

Table 4.8: The Statistical Significance between Reading Performances in Malay and English Respectively

Measures	Malay WRA and English WRA
N	865
Chi-Square ^b	36.992
Asymp. Sig.	.000

a. McNemar Test

b. Continuity Corrected

Note. WRA = word reading accuracy.

4.5.8 Research Question 8: Are poor spellers in Malay also poor spellers in English?

There was a relatively high correlation between Malay and English spelling, $r = .80$ (see Table 4.3). However, an asymptotic McNemar's test determined that there was no statistically significant difference between Malay and English spelling, $p = .492$. The results suggest that not all poor spellers in Malay were also poor spellers in English. The proportion of poor/good spellers ($n = 862$, because of missing data) in Malay and English are as follows: poor spellers in both languages (19.8%), good spellers in Malay but poor spellers in English

(6.5%), poor spellers in Malay but good spellers in English (5.6%), and good spellers in both languages (68.1%).

Table 4.9: The Statistical Significance between Spelling Performances in Malay and English Respectively

Measures	Malay Spelling and English Spelling
N	862
Chi-Square ^b	.471
Asymp. Sig.	.492

a. McNemar Test

b. Continuity Corrected

In conclusion, the relationship of word reading accuracy, spelling and handwriting were examined and the results were elaborated in this chapter. The results demonstrate that there was a relatively higher strength of association between reading performances in Malay/English and capital/small letter writing than that of name writing. The data also shows that most of the poor readers in Malay/English were poor in name writing, and slightly more than half of them were poor in capital/small letter writing. The correlation between reading and spelling performances in Malay/English was found to be the highest across measures. Furthermore, the results show that most of the poor readers in Malay/English also performed poorly in spelling. Although not all poor readers/spellers in Malay were also poor readers/spellers in English, the tendency for students to be poor readers/spellers in both languages was relatively high. Finally, students performed better in Malay compared to English in both reading and spelling measures.

CHAPTER 5

DISCUSSION AND CONCLUSION

5.1 Key Findings

The goal of the present study was to investigate the role of handwriting and spelling in identifying RD in Malay and English, among young multilingual learners in Malaysia. The measures for reading, spelling, and handwriting quality were examined. First and foremost, this study addressed the handwriting quality of poor readers in Malay/English. The results demonstrate that there was a relatively higher strength of association between reading performances in Malay/English and capital/small letter writing than that of name writing. The data also shows that most of the poor readers in Malay/English were poor in name writing, and slightly more than half of them were poor in capital/small letter writing. Both name and letter writing can aid the development of spelling and early writing skills of young learners (Puranik et al., 2011). Name writing, however, is often taught by parents and therefore, may not be a relevant outcome measure (Graham et al., 2018). Considering that the handwriting skills of these early writers are still developing, the overall legibility of the handwriting can still be improved with continuous practice (Graham, 1999). Gosse and Reybroeck (2021) also reported that students with RD and typically developing students had equivalent handwriting quality, thus rejecting the hypothesis of handwriting as an additional graphomotor deficit in RD.

Subsequently, this study also addressed the Malay/English spelling performances of poor readers in the respective languages. The correlation between reading and spelling performances in Malay/English was found to be the highest across measures. The results demonstrate that most of the poor readers in Malay/English also performed poorly in

spelling. There was a high percentage of poor readers in Malay who could not read/spell hyphenated doubled-word with diphthong ‘ua’ and suffix ‘an’ such as *buah-buahan* (fruits; see Appendix P). Students who spelt it as <buha buha> or <bubu> might have captured some phonemes but did not blend the diphthong and thus could not produce a phonetically related word. Likewise, they also struggled to read/spell words with similar structures like *berhati-hati* (be careful) and *menyiram* (watering). On the other hand, most poor readers in English could not read/spell a high-frequency word such as *want* (see Appendix Y). Some spelt it as <wan>, which was phonetically related and would be more acceptable in comparison to <one>, which was orthographically incorrect. Similarly, they were also unable to read/spell a multisyllabic word like *shoulder*. Some students spelt it as <holde> or <soder>, phonetically related, but without blending. The partially correct spelling (orthographically incorrect), but phonetically correct spelling may indicate a lack of awareness in orthographically correct spelling in both languages, therefore explicit and individualised spelling instruction is warranted (Lee & Al Otaiba, 2017).

Additionally, it is noteworthy that a small percentage of poor readers were relatively good spellers. This might be due to the memorisation of high-frequency words (e.g., *your*, *sick*, *susu*, and *gula*). Contrary to Ehri’s (2002, p. 19) “two sides of the same coin” that decoding and encoding operate on the same kinds of grapheme-phoneme processes, some underlying factors may be present in this study and warrant future investigation. Roncoli and Masterson (2016) pointed out that the possible causes of unexpectedly poor spelling are phonological difficulty, inefficient orthographic processing as well as a deficit of visual processing and graphemic buffer. Nonetheless, as spelling encompasses phonological, orthographic, morphological, and semantic knowledge words, spelling is inevitable in written expression and linguistic development (Russak & Kahn-Horwitz, 2015). Hence,

spelling is a better indicator of reading skills as compared to handwriting due to its sensitivity toward phonological components in letters and words.

Moreover, although not all poor readers/spellers in Malay were also poor readers/spellers in English, the tendency for students to be poor readers/spellers in both languages was relatively high. There were 22.5% of poor readers and 19.8% of poor spellers in both languages. Students who were poor in Malay reading/spelling were likely to perform poorly in English reading/spelling. A previous study that examined the English orthographic depth among Malay learners in primary school revealed that they were prone to have orthographic errors in English, specifically consonant and vowel errors, which is primarily due to the complexity of the English orthography and the influence of the first language and secondarily, the inadequate exposure to print (Samuddin & Krish, 2018). However, despite its shallow orthography, when Malay words become multisyllabic, poor readers may still be unable to recognise syllable structures accurately (Lee & Wheldall, 2011). Even so, since most students in this study spoke Sarawak Malay as their first language, it was apparent that their reading/spelling abilities might be greatly influenced by their first language. The findings suggest that students performed better in Malay compared to English as the reading and spelling scores in Malay were higher than that in English at the 25th percentile (see Table 4.2). Furthermore, the high correlation between WRA and spelling in Malay also indicates that there is a high chance that students who have poor/good spelling skills in Malay also have poor/good reading skills in Malay. Therefore, Malay may be a more reliable medium to indicate the presence of reading deficits in the context of multilingual learners whose primary language is not English but Malay or the Malay dialect.

In sum, poor readers with poor handwriting did not necessarily have poor spelling skills as well. Even though the Simple View of Writing (Berninger et al., 2002) emphasised that handwriting and spelling are intercorrelated and are known as transcription skills, but the results show that this is not always the case. Besides that, reading or decoding skills as mentioned in the Simple View of Reading (Gough & Tunmer, 1986) and spelling are not always two sides of a coin as suggested by Ehri (2000, p. 19). Not all poor readers are always poor spellers and vice versa. However, spelling is deemed to be a better indicator of reading difficulties compared to handwriting.

5.2 Limitations and Future Directions

There are several limitations related to this study. First, the study findings cannot be generalised to children from other settings (e.g., rural locations). Moreover, the high number of Malay students in public schools resulted in oversampling of Malay-speaking students. Thus, the sample hindered the investigation of the impact of different first languages on students' literacy development. The multilingual profiles and literacy development of the participants could have been more comprehensive if the impact of different first languages was investigated. Second, the reading process was not video recorded. Therefore, any presence of partial accuracy could not be observed. Additionally, the dichotomous rubrics in word reading accuracy did not permit partial correctness. Furthermore, handwriting fluency was not administered. Fourth, the current study only used the 25th percentile as the cut-off criterion. It is crucial for future studies to include different percentile ranks to observe a wider range of performance across reading, spelling, and handwriting measures. Thus, the nuanced relation between handwriting difficulties and RD could not be fully determined in this study. Lastly, working memory assessments such as digit and visual span tests (Cabbage

et al., 2017) that were not included in the current study should be investigated for a comprehensive understanding of the nuances in cognitive profiles among children with RD.

5.3 Implications for Policy and Practice

The early identification of RD is important for appropriate early interventions to take place. These findings bear crucial implications on how handwriting and spelling can be used to detect RD in English and Malay among young multilingual learners. Although handwriting quality only demonstrates minor differences in identifying RD, its characteristics may still be potentially useful for informing teachers when conducting reading assessments. Spelling, on the other hand, is a stronger indicator for RD. Nonetheless, the findings suggest that not every poor reader is a poor speller, and not every poor speller is a poor reader, irrespective of the language assessed. The responses in the assessments may also indicate students' inadequate exposure to print in both languages, thus there is an urgency to foster explicit and systematic interventions, which are promising for improving foundational reading skills (Al Otaiba et al., 2021). Likewise, schools need to foster handwriting instruction as it provides beneficial neuronal activation patterns for learning (Ose Askvik et. al, 2020). Repeated practice in recalling and reproducing letter forms that are incorporated into handwriting intervention may also produce a significant impact on early reading skills (Ray et al., 2021). Finally, this study sheds light on the cross-linguistic reading and spelling abilities among young multilingual learners, which inform practitioners regarding the difficulties faced in both languages that are taught in Malaysian schools.

5.4 Conclusion

The present study has examined the relationship of handwriting, spelling and word reading accuracy among multilingual Primary 1 poor readers. The findings suggest that not

all poor readers in Malay/English were poor in handwriting and spelling in the respective languages. Nevertheless, spelling is a better indicator of identifying RD among multilingual learners as compared to handwriting. The results have also demonstrated that not all poor readers/spellers in Malay were also poor readers/spellers in English. However, most of the poor readers/spellers were rather poor in English.

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APPENDICES

Appendix A

A Sample of Instrument for Name Writing Test

	NAME WRITING <i>PENULISAN NAMA</i> TEST ADMINISTRATOR'S COPY <i>SALINAN PENTADBIR UJIAN</i>
Say: <i>Please write your full name in the space provided (point to the lined paper on the STUDENT COPY).</i> Katakan: <i>Sila tulis nama penuh anda di dalam ruang yang disediakan (tunjukkan ruang di atas SALINAN PELAJAR).</i>	
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Note. Adapted from Lee (2021).

Appendix B

A Sample of Instrument for Capital Letter Writing



LETTER WRITING (CAPITAL LETTERS)
PENULISAN ABJAD (HURUF BESAR)
TEST ADMINISTRATOR'S COPY
SALINAN PENTADBIR UJIAN

INSTRUCTION TO TEST ADMINISTRATOR: If the student cannot write the letter after 3 seconds, please name the following letter. Use the timer to gauge the 3 second-time elapsed.

MAKLUMAN UNTUK PENTADBIR UJIAN: Jika pelajar tidak boleh menulis huruf itu selepas 3 saat, sila namakan huruf yang seterusnya. Sila guna jam randik untuk menentukan masa 3 saat.

Say: Please write the capital letters in the space provided here (point to the *STUDENT COPY*).

Katakan: Sila tulis huruf besar di dalam ruang yang disediakan di sini (tunjuk pada *SALINAN PELAJAR*).

No.	letter
1.	A
2.	B
3.	P
4.	C
5.	O
6.	X
7.	S
8.	V
9.	E
10.	T

No.	letter
11.	L
12.	I
13.	H
14.	J
15.	Q
16.	U
17.	G
18.	K
19.	Y
20.	N

No.	letter
21.	Z
22.	R
23.	W
24.	M
25.	F
26.	D

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Note. Adapted from Lee (2021).

Appendix C

A Sample of Instrument for Small Letter Writing



LETTER WRITING (SMALL LETTERS)
PENULISAN ABJAD (HURUF KECIL)

TEST ADMINISTRATOR'S COPY
SALINAN PENTADBIR UJIAN

INSTRUCTION TO THE TEST ADMINISTRATOR: If the student cannot write the letter after 3 seconds, please name the following letter. Use the timer to gauge the 3 second-time elapsed.

MAKLUMAN UNTUK PENTADBIR UJIAN: Jika pelajar tidak boleh menulis huruf itu selepas 3 saat, sila namakan huruf yang seterusnya.

Say: Please write the small letters in the space provided here (point to the *STUDENT COPY*).

Katakan: Sila tulis huruf kecil di dalam ruang yang disediakan di sini (tunjuk pada *SALINAN PELAJAR*).

No.	letter
1.	e
2.	c
3.	m
4.	l
5.	w
6.	o
7.	f
8.	p
9.	s
10.	v

No.	letter
11.	x
12.	i
13.	r
14.	h
15.	y
16.	b
17.	d
18.	a
19.	g
20.	n

No.	letter
21.	t
22.	k
23.	j
24.	u
25.	z
26.	q

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Note. Adapted from Lee (2021).

Appendix D

A Sample of Instrument for Spelling in Malay



EJAAN (10 PATAH PERKATAAN)
SALINAN PENTADBIR UJIAN

Kata, Saya akan baca beberapa perkataan. Sila tulis ejaan setiap perkataan dengan betul.
Kata, Nombor 1. **Susu** (berhenti seketika). Sani suka minum **susu**. **Susu**.
 Nombor 2. **Gula** (berhenti seketika). Semut suka makan **gula**. **Gula**.
 Nombor 3.....Nombor 10.

No.	Perkataan	Perkataan di dalam ayat yang di baca
1.	susu	Nombor 1. Susu (berhenti seketika). Bayi suka minum susu . Tulis susu .
2.	gula	Nombor 2. Gula (berhenti seketika). Semut suka makan gula . Tulis gula .
3.	kerusi	Nombor 3. Kerusi (berhenti seketika). Duduk di atas kerusi . Tulis kerusi .
4.	epal	Nombor 4. Epal (berhenti seketika). Adik suka makan epal . Tulis epal .
5.	penyu	Nombor 5. Penyu (berhenti seketika). Laut itu ada penyu Tulis penyu .
6.	Isnin	Nombor 6. Isnin (berhenti seketika). Hari ini hari Isnin . Tulis isnin .
7.	menyiram	Nombor 7. Menyiram (berhenti seketika). Huda menyiram bunga. Tulis menyiram .
8.	terjatuh	Nombor 8. Terjatuh (berhenti seketika). Dia terjatuh . Tulis terjatuh .
9.	berhati-hati	Nombor 9. Berhati-hati (berhenti seketika). Sila berhati-hati di jalan raya. Tulis berhati-hati .
10.	Buah-buahan	Nombor 10. Buah-buahan (berhenti seketika). Saya suka makan buah-buahan . Tulis buah-buahan .

Ref No.: _____

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Note. Adapted from Lee (2021).

Appendix E

A Sample of Instrument for Spelling in English



SPELLING (10 ITEMS)
TEST ADMINISTRATOR'S COPY

Say, I am going to read out some words. Please write out the spelling of each word that I read aloud correctly.

Say, Number 1 pretty (pause). That is a pretty dress. Pretty.

Number 2. Sick (pause). The boy is sick. Sick.

Number 3. Thick (pause). The book is so thick. Thick.

Number 5....Number 10...

No.	Word	Word in the statement
1.	pretty	Number 1. Pretty (pause). She is pretty . Write pretty .
2.	sick	Number 2. Sick (pause). The boy is sick . Write sick .
3.	thick	Number 3. Thick (pause). The book is thick . Write thick .
4.	your	Number 4. Your (pause). This is your bag. Write your .
5.	shark	Number 5. Shark (pause). There is a shark . Write shark .
6.	shoulder	Number 6. Shoulder (pause). Alice hurt her shoulder . Write shoulder .
7.	elephant	Number 7. Elephant (pause). I saw an elephant . Write elephant .
8.	name	Number 8. Name (pause). Her name is Sani. Write name .
9.	them	Number 9. Them (pause). I saw them . Write them .
10.	want	Number 10. Want (pause). I want an apple. Write want .

Ref No.: _____

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1

Note. Adapted from Lee (2021).

Appendix F

A Sample of Instrument for Malay Word Reading Accuracy

	PEMBACAAN PERKATAAN (10 PATAH PERKATAAN)
	SALINAN PELAJAR

1. susu
2. gula
3. kerusi
4. epal
5. penyu
6. Isnin
7. menyiram
8. terjatuh
9. berhati-hati
10. buah-buahan

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3

Note. Adapted from Lee (2021).

Appendix G

A Sample of Instrument for English Word Reading Accuracy

	WORD READING ACCURACY INSTRUMENT (10 ITEMS)
	STUDENT COPY
1.	pretty
2.	sick
3.	thick
4.	your
5.	shark
6.	shoulder
7.	elephant
8.	name
9.	them
10.	want
Ref No.: _____	©ReadWell Diagnostics Group
	3

Note. Adapted from Lee (2021).

Appendix H

Validity and Reliability

Table 1: Convergent Validity Across Measures

Measures		<i>r</i>
English WRA	Name writing	0.45
	Capital letter writing	0.52
	Small letter writing	0.51
	English spelling	0.71
Malay WRA	Name writing	0.41
	Capital letter writing	0.59
	Small letter writing	0.61
	Malay spelling	0.90

Note. WRA = word reading accuracy; *r* = correlation coefficient.

Table 2: Reliability Test Using Kuder-Richardson Formula 20

Measures	Cronbach's Alpha
Name writing	0.979
Capital letter writing	0.946
Small letter writing	0.953
Malay spelling	0.959
English spelling	0.948

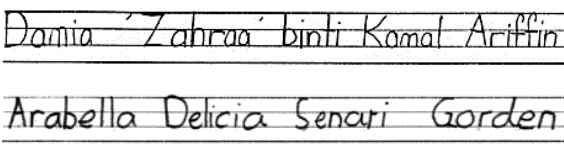
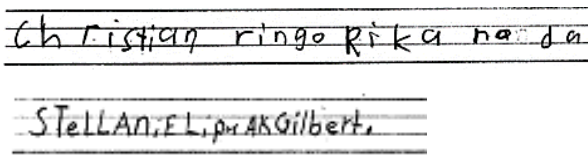
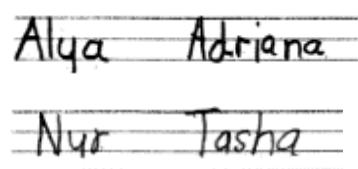
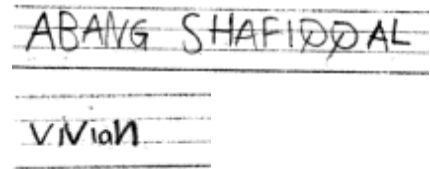
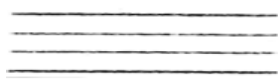
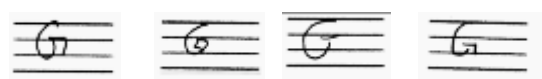
Table 3: Test-retest Reliability of Untimed Measure (Lee et al., 2020)

Measures	First Testing^a		Second Testing^b		<i>r</i>
	Mean	<i>SD</i>	Mean	<i>SD</i>	
Malay WRA	7.34	3.61	8.70	2.80	0.98
English WRA	3.69	3.68	5.65	3.65	0.86

Note. ^a $n = 865$; ^b $n = 46$; WRA = word reading accuracy; *SD* = standard deviation; r = correlation coefficient.

Appendix I

Summary of Scoring Metric for All Assessments

Scoring Metric	Descriptions	Example(s)
Name Writing (Jee & Lee, 2014)	4 – full name written with appropriate letter formation, spacing, capitalisation, no reversals, and/or no spelling mistakes	
	3 – full name written with inappropriate letter formation, spacing, capitalisation, reversal, and/or spelling mistakes	
	2 – first name written with appropriate letter formation, spacing, capitalisation, no reversals, and/or no spelling mistakes	
	1 – first name written with inappropriate letter formation, spacing, capitalisation, reversal, and/or spelling mistakes	
	0 – no name written, scribbles, and/or unrecognisable symbols	
Letter writing (Jee & Lee, 2014)	Samples of letters written when a capital letter G was dictated.	
	2 – correct letter written with good letter formation	
	1 – correct letter written with poor letter formation	
	0 – no answer, wrong letter, substitution, and/or reversal	

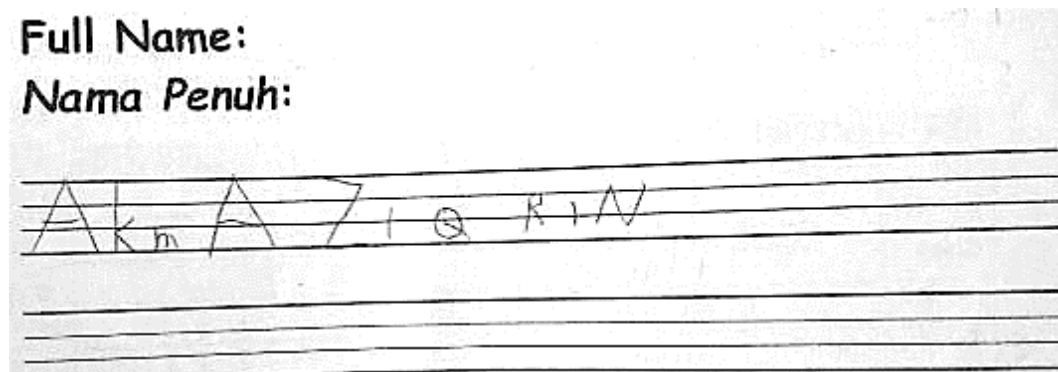
continued

Spelling	This metric determines students' phonological representations in spelling. The score for each word ranges between 0 and 6.	Malay word: <i>terjatuh</i>	English word: <i>pretty</i>
	0 – no relation between the letters or random strings of letters	<n>	<F>
	1 – A phonologically related letter (initial sound or another sound in the word)	<pepato>	<Ros>
	2 – initial sound represented by the correct letter, with and without any other letters.	<Te>	<Ph>
	3 – initial sound spelled correctly and there are more than one phonemes spelled correctly.	<trJtoh>	<periti>
	4 – all phonemes are represented with phonetically related letters	<teHatul>	<preti>
	5 – all phonemes are represented with conventional letters	<terJato>	<prety>
	6 – correct spelling	<terjatuh>	<pretty>
Word Reading Accuracy (WRA)	1 – accurately-read word 0 – inaccurate-read word	-	

Appendix J

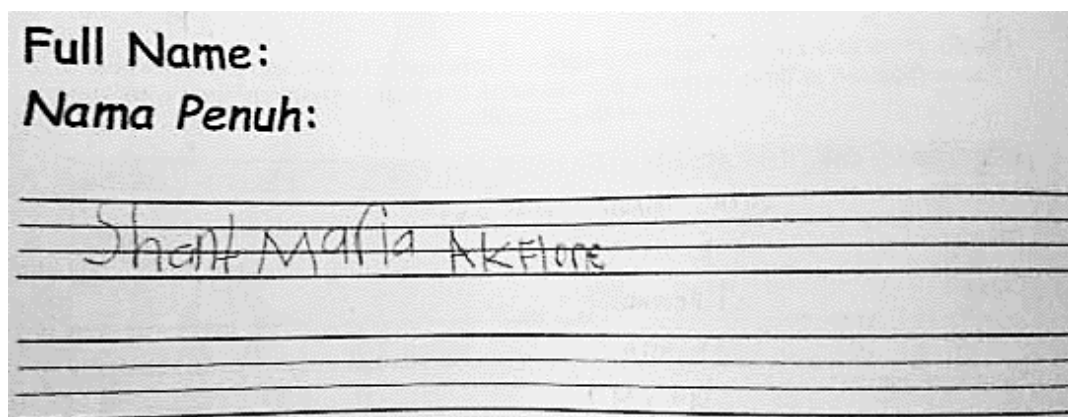
Examples of Poor Readers in Malay who Were Poor/Good in Name Writing

Figure 1: An Example of a Poor Reader in Malay who was Poor in Name Writing



Note. Adapted from Lee (2021). This student scored 0 for Malay WRA and 1 for name writing; the correct name was Akma Ziqrin Bin Jaya.

Figure 2: An Example of a Poor Reader in Malay who was Good in Name Writing



Note. Adapted from Lee (2021). This student scored 4 for Malay WRA and 3 for name writing; the correct name was Shanti Maria Anak Rudy.

Appendix K

An Example of a Poor Reader in Malay who was Poor in Capital Letter Writing

 LETTER WRITING (CAPITAL LETTERS)
PENULISAN ABJAD (HURUF BESAR)
STUDENT BOOKLET

1. A	11. d	21. J
2. A	12. b	22. b
3. P	13. b	23. J
4. g	14. b	24. b
5. o	15. d	25. X
6. b	16. b	26. Z
7.	17. J	
8. b	18. b	
9. d	19. d	
10.	20. b	

Ref No. _____ ©ReadWell Diagnostics Group 2

Note. Adapted from Lee (2021). This student scored 0 for Malay WRA and 3 for capital letter writing.

Appendix L

An Example of a Poor Reader in Malay who was Good in Capital Letter Writing

UNIVERSITI MALAYSIA GEMILANG

LETTER WRITING (CAPITAL LETTERS)
PENULISAN ABJAD (HURUF BESAR)
STUDENT BOOKLET

1. A
2. B
3. P
4. C
5. O
6. X
7. S
8. V
9. F
10. I
11. L
12. T
13. H
14. J
15. Q
16. U
17. G
18. K
19. Y
20. N
21. Z
22. R
23. W
24. M
25. E
26. D

Ref No. _____

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2

Note. Adapted from Lee (2021). This student scored 1 for Malay WRA and 33 for capital letter writing.

Appendix M

An Example of a Poor Reader in Malay who was Poor in Small Letter Writing

UNIVERSITI MALAYSIA KAMPAR
UNIMAK

LETTER WRITING (SMALL LETTERS)
PENULISAN ABJAD (HURUF KECIL)
STUDENT BOOKLET

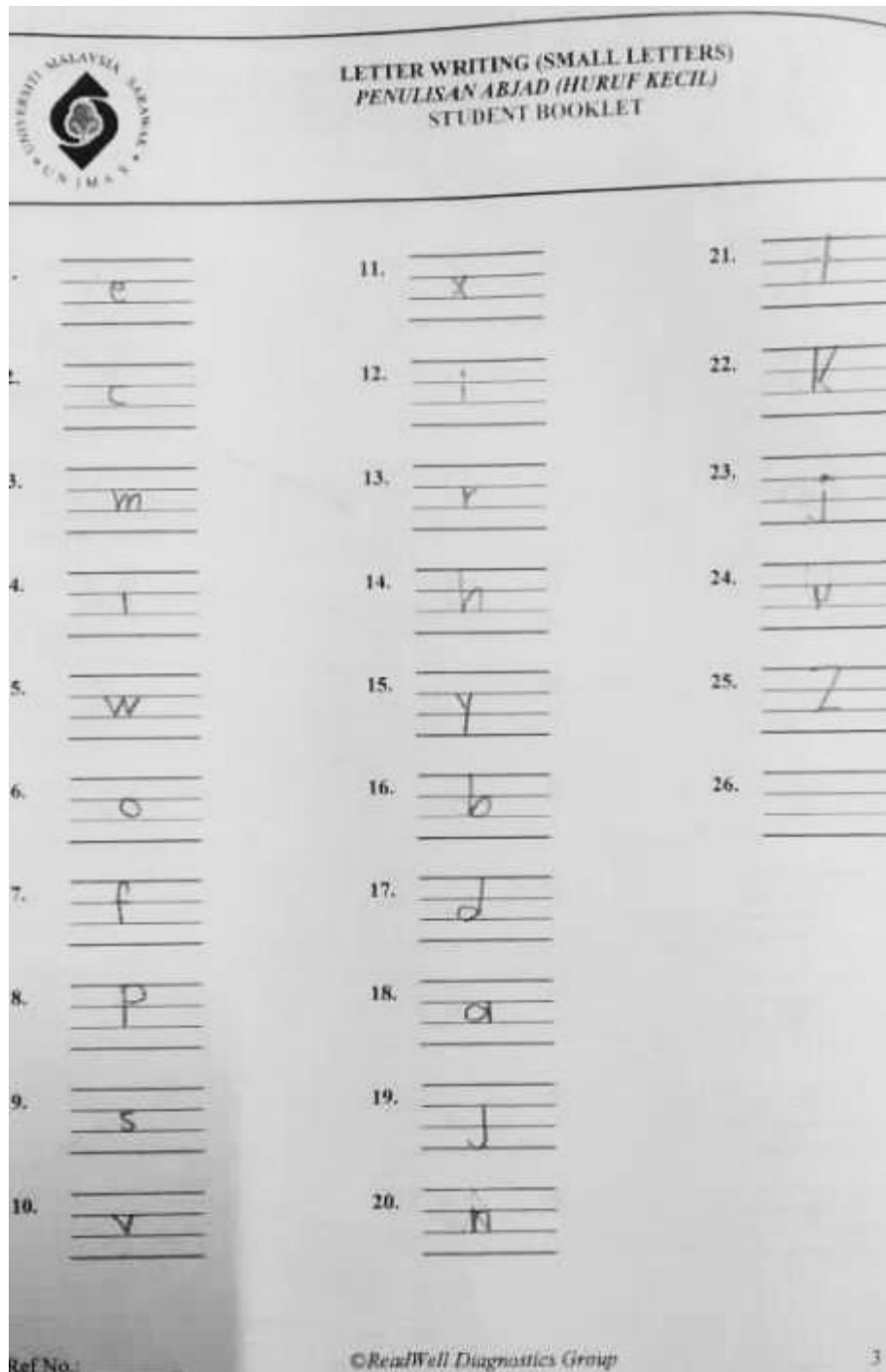
1.	11.	21.
2.	12.	22.
3.	13.	23.
4.	14.	24.
5.	15.	25.
6.	16.	26.
7.	17.	
8.	18.	
9.	19.	
10.	20.	

Ref No.: _____ ©ReadWell Diagnostics Group 7

Note. Adapted from Lee (2021). This student scored 1 for Malay WRA and 13 for small letter writing.

Appendix N

An Example of a Poor Reader in Malay who was Good in Small Letter Writing



Note. Adapted from Lee (2021). This student scored 1 for Malay WRA and 30 for small letter writing.

Appendix O

Crosstabulation of Malay Spelling Performances of Poor Readers in Malay

		<i>susu</i>		<i>gula</i>		<i>kerusi</i>		<i>epal</i>		<i>penyu</i>		<i>Isnin</i>		<i>menyiram</i>		<i>terjatuh</i>		<i>berhati-hati</i>		<i>buah-buahan</i>	
WRA Scores		0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
PC Scores	0	27	10	85	11	78	15	80	8	117	5	124	4	145	-	139	1	146	-	150	1
	1	1	1	12	5	4	2	35	8	14	-	38	2	7	-	7	1	13	-	2	-
	2	18	2	16	1	59	18	5	3	18	2	3	-	58	1	47	-	52	1	62	2
	3	8	12	23	17	11	12	38	20	42	3	35	6	4	-	10	2	2	1	3	-
	4	1	-	2	3	-	-	11	5	12	4	-	-	4	-	8	1	1	2	-	-
	5	-	2	1	2	6	2	1	3	1	-	-	-	-	-	2	-	1	-	-	-
	6	21	118	22	21	4	10	2	2	2	1	3	6	2	-	3	-	2	-	1	-

Note. As a result of missing data, $n = 221$; phonological coding = PC; word reading accuracy = WRA; For WRA scores: 0 = cannot read; 1 = can read.

Appendix P

Analysis of Spelling Errors in Malay and its Examples for Poor Readers in Malay who Cannot Read

Scores	0		1		2		3		4		5		6
Descriptions	No relation between the letters or random strings of letters		A phonologically related letter (initial sound or another sound in the word)		Initial sound represented by the correct letter, with and without any other letters.		Initial sound spelled correctly and there are more than one phoneme spelled correctly.		All phonemes are represented with phonetically related letters		All phonemes are represented with conventional letters		Correctly spelt
	<i>n</i>	Examples	<i>n</i>	Examples	<i>n</i>	Examples	<i>n</i>	Examples	<i>n</i>	Examples	<i>n</i>	Examples	<i>n</i>
<i>buah-buahan</i>	150	up, F, susu	2	uaua, n	62	baba, buha buha. Buyanhan	3	duah-duah han, buha-buhahan	-		-		1
<i>berhati-hati</i>	146	A, d	13	B, at, mati, Pehaha, tin	52	B, berti berti, hati	2	behati-behati, bett hati-hata	1	behati hati	1	Berhati hati	2
<i>menyiram</i>	145	baik, B	7	Ber, rila, r, N	58	m, mene, Neria	4	Menira, merirun, melilan	4	meniram, meneram	-		2
<i>terjatuh</i>	139	n, fam	7	pepato	47	t, Te, J, tit, tai, jatu	10	TeGaTo, trJtoh, tejtuh	8	teHatul, tejatos	2	terJato, terjatoh	3

continued

<i>Isnin</i>	124	A, w	38	S, SaSa, Selsn,	3	Igaram, ia	35	Isnisi, sinin, seni, Isnii, Isini	-		-		3
<i>penyu</i>	117	Aasw, baa	14	ua, uun, bune	18	p, pun, pg	42	Pe, Panu, peru, Pena, peyua	12	penu, pegu, peneu	1	penyi	2
<i>gula</i>	85	p	12	k, jg, uknu	16	g, gia, gak, gigi	23	ula, guia, gala, gual, Gla	2	guna, gura	1	gola	22
<i>epal</i>	80	qla, BuBu	35	A, Aha, pp	5	e, ep, eak	38	epa, eppl, Aple, Epla, pal	11	apel, apal, eapaL	1	epel	2
<i>kerusi</i>	78	ecghe, Aa	4	si, s, kuSi	59	k, kuci, kere	11	kernsi, Keuc, kurusi	-		6	Keresi, kerasi	4
<i>susu</i>	27	TmT, p, J	1	Sata	18	S, say, u, saya, sata	8	usu, sus, sas, usas	1	sussu	-		21

Appendix Q

An Example of a Poor Reader in Malay who was Also a Poor Speller in Malay

 **EJAAN (10 PATAH PERKATAAN)**
BUKU JAWAPAN PELAJAR

1. SuSu
2. Jak
3. kab
4. bigk
5. pick
6. Isiu
7. baik
8. koul
9. okbul
10. uoliHk

Ref No.: _____ © ReadWell Diagnostics Group

Note. Adapted from Lee (2021). This student scored 1 for Malay WRA and 15 for spelling in Malay.

Appendix R

An Example of a Poor Reader in Malay who was a Good Speller in Malay

		EJAAN (10 PATAH PERKATAAN)	
		BUKU JAWAPAN PELAJAR	
1.	Susu		
2.	Gula		
3.	Kusi		
4.	Apei		
5.	Punu		
6.	Isnin		
7.	Miram		
8.	Tajatuh		
9.	berti bert		
10.	ban		

Ref No.: _____

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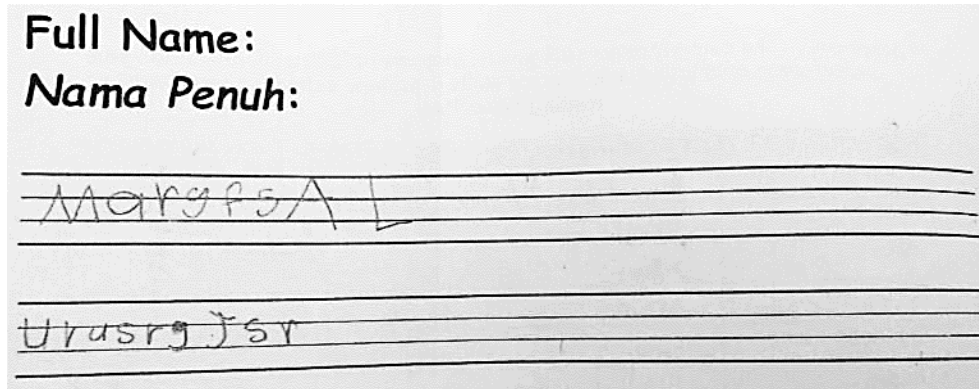
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Note. Adapted from Lee (2021). This student scored 1 for Malay WRA and 36 for spelling in Malay.

Appendix S

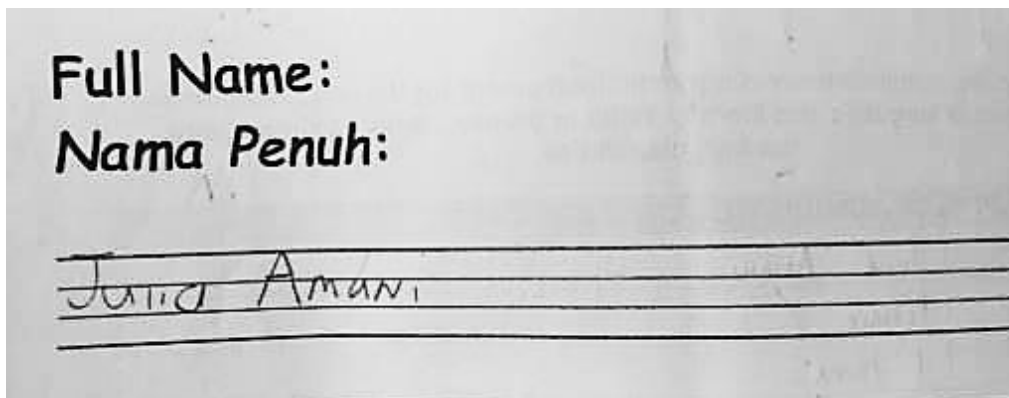
Examples of Poor Readers in English who Were Poor/Good in Name Writing

Figure 1: An Example of a Poor Reader in English who was Poor in Name Writing



Note. Adapted from Lee (2021). This student scored 0 for English WRA and 0 for name writing; the correct name was Nur Aulya Natasha Binti Abdullah.

Figure 2: An Example of a Poor Reader in English who was Good in Name Writing



Note. Adapted from Lee (2021). This student scored 0 for English WRA and 3 for name writing; the correct name was Julia Amani.

Appendix T

An Example of a Poor Reader in English who was Poor in Capital Letter Writing

 LETTER WRITING (CAPITAL LETTERS)
PENULISAN ABJAD (HURUF BESAR)
STUDENT BOOKLET

1. A	11. X	21. Z
2. B	12.	22.
3. C	13. H	23.
4. D	14. J	24.
5. E	15.	25.
6. F	16. U	26.
7.	17. D	
8.	18. K	
9. C	19. J	
10.	20.	

Ref No.: _____

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Note. Adapted from Lee (2021). This student scored 0 for English WRA and 14 for capital letter writing.

Appendix U

An Example of a Poor Reader in English who was Good in Capital Letter Writing

UNIVERSITI MALAYSIA SARAWAK
UNIMAS

LETTER WRITING (CAPITAL LETTERS)
PENULISAN ABJAD (HURUF BESAR)
STUDENT BOOKLET

1. F	11. I	21. Z
2. B	12. T	22. R
3. P	13. H	23. W
4. C	14. L	24. M
5. O	15. Q	25. F
6. X	16. U	26. D
7. S	17. J	
8. V	18. K	
9. E	19. Y	
10. T	20. N	

Ref No.: _____

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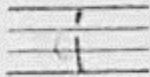
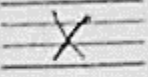
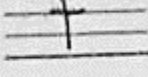
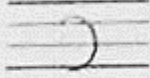
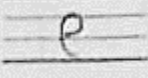
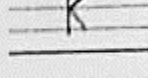
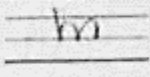
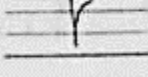
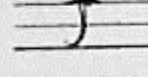
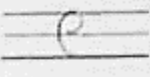
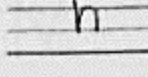
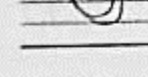
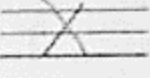
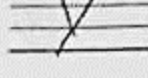
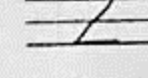
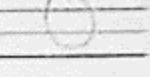
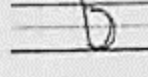
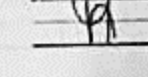
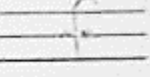
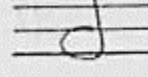
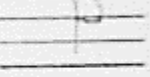
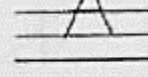
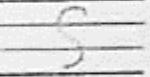
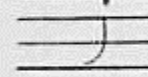
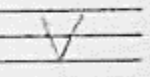
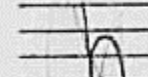
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Note. Adapted from Lee (2021). This student scored 0 for English WRA and 35 for capital letter writing.

Appendix V

An Example of a Poor Reader in English who was Poor in Small Letter Writing

 **LETTER WRITING (SMALL LETTERS)**
PENULISAN ABJAD (HURUF KECIL)
STUDENT BOOKLET

1. 	11. 	21. 
2. 	12. 	22. 
3. 	13. 	23. 
4. 	14. 	24. 
5. 	15. 	25. 
6. 	16. 	26. 
7. 	17. 	
8. 	18. 	
9. 	19. 	
10. 	20. 	

Ref No.: _____ ©ReadWell Diagnostics Group

Note. Adapted from Lee (2021). This student scored 0 for English WRA and 9 for small letter writing.

Appendix W

An Example of a Poor Reader in English who was Good in Small Letter Writing

 **LETTER WRITING (SMALL LETTERS)**
PENULISAN ABJAD (HURUF KECIL)
STUDENT BOOKLET

1. e	11. s	21. t
2. c	12. i	22. k
3. m	13. n	23. j
4. l	14. h	24. a
5. w	15. g	25. z
6. o	16. b	26. q
7. f	17. d	
8. p	18. u	
9. s	19. o	
10. v	20. h	

RefNo: _____ ©ReadWell Diagnostics Group 3

Note. Adapted from Lee (2021). This student scored 0 for English WRA and 40 for small letter writing.

Appendix X

Crosstabulation of English Spelling Performances of Poor Readers in English

		pretty		sick		thick		your		shark		shoulder		elephant		name		them		want	
WRA scores		0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
PC scores	0	148	-	135	-	164	-	184	-	190	-	204	-	176	-	190	-	177	-	222	-
	1	35	-	25	-	13	-	24	-	26	-	19	-	37	-	14	-	28	-	28	-
	2	27	-	22	-	26	-	11	-	19	-	13	-	35	-	14	-	3	-	5	-
	3	62	-	50	-	88	-	45	-	56	-	48	-	35	-	27	-	82	-	35	-
	4	14	-	10	-	-	-	2	-	-	-	6	-	8	-	43	-	1	-	1	-
	5	4	-	46	-	-	-	23	-	-	-	1	-	-	-	-	-	-	-	-	-
	6	1	-	3	-	-	-	2	-	-	-	-	-	-	-	3	-	-	-	-	-

Note. As a result of missing data, $n = 291$; phonological coding = PC; word reading accuracy = WRA; For WRA scores: 0 = cannot read; 1 = can read.

Appendix Y

Analysis of Spelling Errors in English and its Examples for Poor Readers in English who Cannot Read

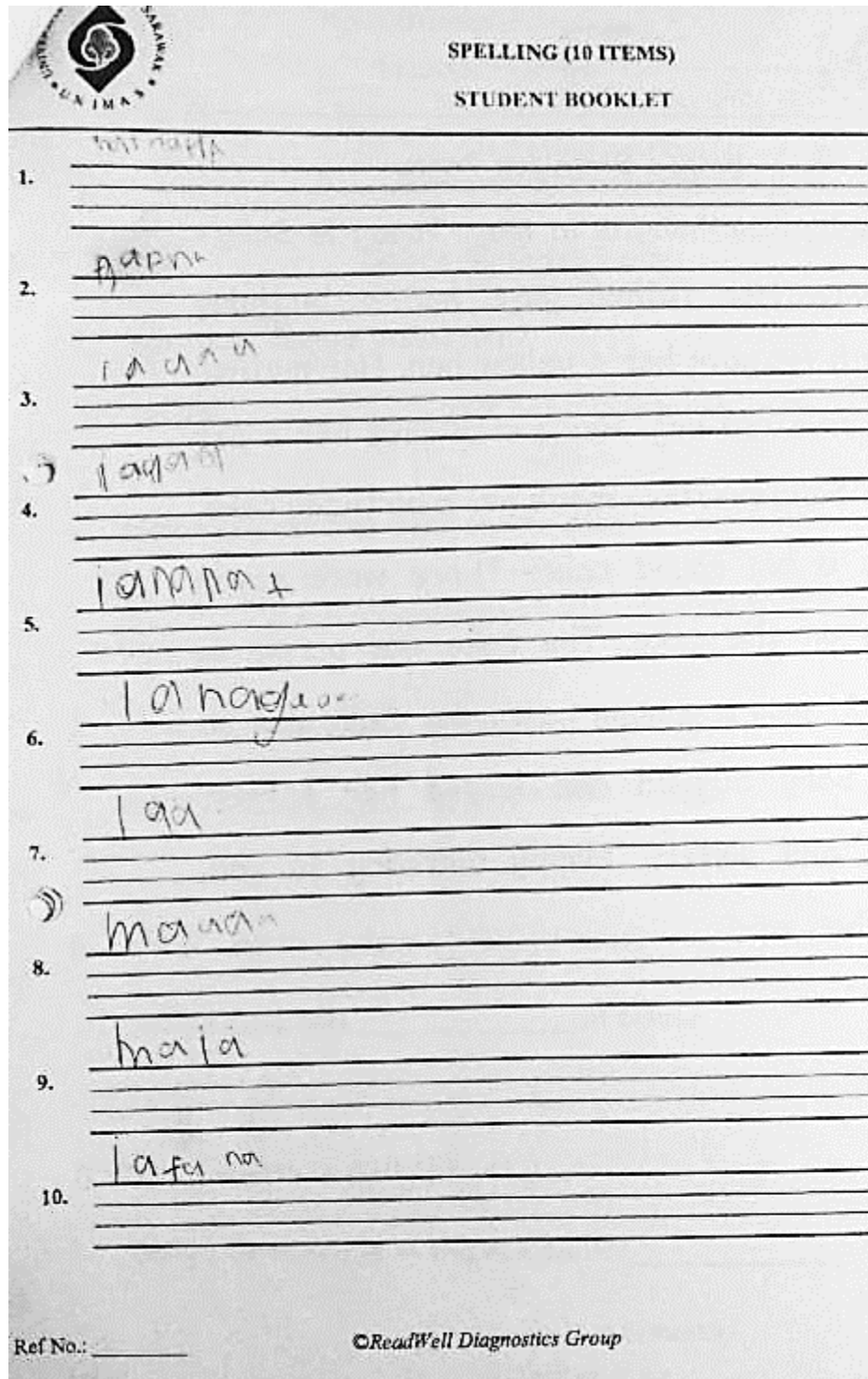
Scores	0		1		2		3		4		5		6
Descriptions	No relation between the letters or random strings of letters		A phonologically related letter (initial sound or another sound in the word)		Initial sound represented by the correct letter, with and without any other letters.		Initial sound spelled correctly and there are more than one phonemes spelled correctly.		All phonemes are represented with phonetically related letters		All phonemes are represented with conventional letters		Correctly spelt
	<i>n</i>	Examples	<i>n</i>	Examples	<i>n</i>	Examples	<i>n</i>	Examples	<i>n</i>	Examples	<i>n</i>	Examples	<i>n</i>
want	222	i, in, una	28	one, tan,	5	w, way	35	wan, wat, wane	1	weant	-		-
shoulder	204	b, Kr,	19	ros, L, O	13	Sa, SAduh	48	holde, sobo, hoho	6	SoDer, Shodr,	1	SholDer	-
shark	190	Fi, na	26	r, ca, h, aa, c	19	s, sot, smis	56	sat, Shyk, sar, shek, Sharr	-		-		-
name	190	Kurn, tul, ai	14	m,	14	n, nc	27	nim, nin, nat, Mam	43	nam, nem, mene	-		3
your	184	r, gah	24	ro, O, ran, u	11	Ya, y,	45	yo, yous, jor, yr, yay	2	yaar, uor	23	yor, you, your, yoir	2

continued

them	177	bi,	28	maia, D, bm	3	tiaa,	82	dem, Dam, den, tam	1	YtnimK	-		-
elephant	176	ka	37	l, al	35	ala, e, aley	35	aLifen, LaliFe	8	EliFen, leafan	-		-
thick	164	lb, Mal	13	ke, wat	26	t, tb, tn	88	tik, titi, tip, tig	-		-		-
pretty	148	F	35	t, Ros	27	p, Ph	62	pit, periti, perti	14	peti, piti, preti	4	prety, priti, pritty	1
sick	135	db,	25	c, Knus	22	s, ss, sat,	50	Sit, syx, sis	10	cik, seKe	46	six, sik	3

Appendix Z

An Example of a Poor Reader in English who was Also a Poor Speller in English



 **SPELLING (10 ITEMS)**
STUDENT BOOKLET

1. mitnaga
2. apna
3. ia an n
4. ia an n
5. ia an n
6. ia na n
7. ia
8. ma an
9. ma ia
10. ia fa na

Ref No.: _____ ©ReadWell Diagnostics Group

Note. Adapted from Lee (2021). This student scored 0 for English WRA and 8 for spelling in English.

Appendix A1

An Example of a Poor Reader in English who was a Good Speller in English

 **SPELLING (10 ITEMS)**
STUDENT BOOKLET

1. Piti
2. Sik
3. tik
4. fur
5. ANh
6. Sadu
7. ANAV
8. mem
9. dem
10. ANh

Ref No.: _____

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Note. Adapted from Lee (2021). This student scored 0 for English WRA and 26 for spelling in English.