

Research Paper

INVESTIGATING THE SPELLING PERFORMANCE OF MALTESE CHILDREN

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Abstract. This research investigates Maltese word and non-word spelling abilities of Maltese children. A total of 82 typically developing students attending state and church schools in grades 4, 5 and 6 participated in the research. Spelling abilities were assessed using a standardized Maltese spelling test and a non-word spelling test developed for the purpose of this study. A comparison of the children's performance in these tests was undertaken in terms of their grade, gender, school-type, school language and home language. Findings show that word and non-word spelling abilities are only significantly affected by grade and school-language. Spelling patterns were analyzed and discussed in light of the dual route model. Four distinctive categories of spelling patterns emerged in this study, which indicated the use of lexical and sub-lexical processes. Overall, findings are discussed in relation to other similar studies.

Keywords: spelling, non-words, dual-route model, literacy, spelling errors, Maltese.

1 Introduction

The relationship between oral and written language is exemplified by the predecessor language skills required for literacy development. Phonological processing skills and language skills including vocabulary, morphology, concepts of prints, sentence correction and processing contribute to reading and spelling abilities. Language skills are necessary for reading comprehension abilities (Fraser & Conti-Ramsden, 2008; Lonigan, Schatschneider & Westberg, 2008). Phonological awareness skills contribute to phoneme-to-grapheme mapping in spelling development (Weinrich & Fay, 2007; Al Oitaba, Puranik, Rouby, Greulich, Sidler & Lee, 2010). Therefore literacy instruction should start with the reinforcement of oral language skills (Rose, 2006).

Many studies looked into the development of spelling and its relation to language skills. Spelling development was initially thought to be a memorization process however researchers started realizing that sound-letter correspondences and phonological awareness skills play a role. As a result, theories of spelling development emerged. According to stage theories, spelling is acquired in stages. Gentry (1982) describes five stages of spelling development. In the *precommunicative* stage children acquire preliminary perceptions about writing; in the *semiphonetic* stage children develop awareness about sound-letter correspondences. In the third *phonetic* stage children's spelling is more conventional and in the *transitional stage* children represent all the letters and morphologic elements. In the final *correct stage*, children's spelling corresponds to their educational level. Ehri (1986) lists three stages which are similar to Gentry's (1982) *semiphonetic*, *phonetic* and *transitional* stages.

These theories, albeit not recent, are successful in providing a simplistic framework of spelling development. However, they are based on English and thus are limited in explaining other languages such as the Maltese/English bilingual context in this study. Spelling development is known to be highly influenced by the specific orthography of the language (Bear, Helman, Templeton, Invernizzi & Johnston, 2007). In Italian spelling development, children mastered phoneme-grapheme conversions earlier in the third grade (Notarnicola, Angelleli, Judica & Zoccolotti, 2012). Similarly, Finnish children incorporated the language's inflectional morphemes in their spelling earlier than initially believed (Lehtonen & Bryant, 2005). Specific linguistic factors including phonological awareness, orthographic knowledge and mental graphemic representations contribute to spelling development in that language (Apel, Masterson & Hart, 2004a). These linguistic factors should therefore be considered in spelling instruction and research on spelling.

Indeed, the Orthographic Depth Hypothesis (ODH) (Katz & Frost, 1992) states that spelling is shaped by the language's orthography. Languages differ in the way phonology is represented (Frost, 2005) and languages that represent their phonology with direct phoneme-to-grapheme correspondences are called *shallow* or *transparent* orthographies (*example* Finnish and Hebrew). Languages with more complex phoneme-grapheme correspondences

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are called *deep* or *opaque* orthographies (example English and French). Agius (2012) referred to Maltese as a semi-transparent language because it has direct phoneme-to-grapheme correspondences (Hoberman, 2007) but also has exceptions. Spelling acquisition differs according to the language's orthography. Spelling may develop faster in Maltese than English since Maltese is a semi-transparent language (Agius, 2012).

In the case of bilinguals, spelling development is more complex (Joy, 2011) and different from monolinguals' developmental trajectories (De Sousa, Greenop & Fry, 2011). Bialystok (2002) comments that bilinguals must possess awareness of sounds, words and print in both languages as children with poor oral language skills in preschool were found to have later difficulties in literacy acquisition (Puranik & Lonigan, 2012). There may be positive and negative transfers/effects between L1 and L2 literacy. Agius (2012) found that Maltese spelling is predicted by English spelling fluency. This study explores spelling performance and patterns of bilingual Maltese/English children.

The Dual Route Model (DRM) explains spelling of familiar and unfamiliar words through two processes; the lexical and sub-lexical (Tainturier & Rapp, 2001). Both routes are activated by written input, but the sub-lexical is activated more by novel words, non-words and words with regular grapheme-phoneme correspondences. The lexical route is activated by words stored in the lexicon and words with irregular grapheme-phoneme correspondences (Bates, Castles, Luciano, Wright, Coltheart & Martin, 2007). Cognitive neuropsychology suggests that there is an interaction between the two processes because non-word spelling requiring sub-lexical activation is influenced by real words activated by the lexical route (Tainturier & Rapp, 2001). The sub-lexical route of the DRM is therefore highly utilized in Maltese writing (Agius, 2012) because of its direct phoneme-to-grapheme conversions. However, De Sousa et al. (2011) showed that both routes are utilized in a transparent orthography. Maltese ignores phonological processes like final consonant devoicing and voicing assimilation in writing (Hoberman, 2007). This implies that a strict application of the sub-lexical route would result in spelling errors. The Maltese grapheme *h* and digraph *gh* may also be a source of confusion. These letters are consonants in final positions but have no phonetic value in initial and middle positions (Hoberman, 2007). This study aims to utilize error analysis to investigate the application of the DRM in Maltese word and non-word spelling.

There are multiple classification systems of spelling patterns, however the majority "have concerned English words and are therefore limited to the linguistic and orthographic idiosyncrasies" (Potopapas, Fakou, Drakopoulou, Skaloumbakas & Mouzaki 2013, p.616). Consequently, studies in different languages utilized different classification systems that acknowledge specific language properties. Snowling (1987) distinguishes between *phonological* and *orthographic* errors. Phonological errors alter words' pronunciation while orthographic errors involve incorrect letters. Moats (1995) also included morphological errors in Snowling's (1987) system. Potopapas et al. (2013) classified

errors in Greek (transparent language) into phonological, grammatical, orthographic, stress, punctuation and other defined errors. Similarly, this research classified Maltese spelling patterns using a classification specific to Maltese but influenced by the above studies.

This study is driven by the following research questions:

1. How do Maltese children perform in Maltese word and non-word spelling?
2. What spelling patterns are more associated with sub-lexical processing and what spelling patterns are more associated with lexical processing in the dual route model?
3. What do these spelling patterns indicate about the children's knowledge of Maltese spelling?

2 Methods

2.1 Participants

In total, 82 students were included in the study (Table 1). The participants were recruited from three church and three state schools in Malta. All participants were required to be from grades 4-6 and typically developing. Typically developing refers to the absence of difficulties in academic attainment, speech and language development, literacy, emotional, physical or cognitive development. Spoken languages at home and school were identified through the questionnaires' (Xuerab, 2009) survey responses. Ethical approval from the University of Malta Research Ethics Committee was granted (reference number: 038/2013).

Table 1. Sample characteristics

Variables		Frequency
Gender	Males	40
	Females	42
Grade	4	26
	5	27
	6	29
School-type	Church	37
	State	45
Home Language	Me	71
	M/E	11
School Language	Me	47
	Em	6
	M/E	29

2.2 Research design

This research employed a mixed quantitative and qualitative design to allow thorough explanations (Creswell & Plano Clark, 2011). The qualitative part of this study involved spelling patterns analysis while the quantitative design investigated the relationships between the dependent (word and non-word spelling scores and time-taken) and independent variables (gender, grade, school-type, school-language, home-language) and comparison of spelling patterns among the independent variables.

2.3 Research tools

Three research tools were utilized in this study; a standardized Maltese spelling test, a researcher-designed non-word spelling test and a language questionnaire. The Maltese word spelling test forms part of the standardized TORPAM (Aguis, 2012) and has 60 test items divided into groups of 20 test-items corresponding to each of grade 4, 5 and 6.

For the aim of this study, a non-word spelling test that paralleled the content of the Maltese Spelling Test was developed (Agius, 2012). Non-words had the same length as the corresponding real words; however auditory similarity between real words and non-words was avoided. For example the real word *kelb* (dog) corresponded to the non-word *nejġ*. The inclusion of the graphemes *gh* and *h* in non-words was optional since these are silent in Maltese words except in word-final position. Therefore, participants could map phoneme to graphemes directly. The questionnaire

disseminated in Maltese and English (Xuereb, 2009) aimed to investigate the language use in home and school settings.

2.3.1 Administration

Tests were administered in a quiet room at the participants' schools. The questionnaires were completed individually with the participants.

2.4 Data coding and analysis

Every collected score sheet was assigned a number and a code to indicate gender, school-type and grade of the participant. The time taken to complete the test was recorded. The classroom and home language variables were determined from the questionnaire responses. The acronym Me was attributed if Maltese was chosen, M/E was assigned if both Maltese and English were chosen. Em (mostly English) was assigned if participants chose it in school-spoken language. The spelling patterns/errors in each word were analyzed. Notarnicola et al. (2012) analysed and classified spelling patterns/errors to study the DRM route in Italian. A classification system was also developed for this study taking into consideration Maltese orthography and spelling patterns that emerged in other studies described in Section 1. The different types of spelling patterns were also counted. Quantitative analysis was conducted using the IBM SPSS Statistics Version 22 software.

Table 2. Comparison of mean scores and time-taken (grouped by grade)

Subtest	Grade	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		p-value
					Lower Bound	Upper Bound	
Non-word spelling	Grade 4	34.46	13.08	2.56	29.18	39.74	0.026
	Grade 5	41.15	9.34	1.80	37.45	44.84	
	Grade 6	42.59	11.81	2.19	38.09	47.08	
Non-word spelling time taken	Grade 4	854.04	201.94	39.60	772.5	935.60	0.000 ^a
	Grade 5	714.04	77.33	14.88	683.45	744.63	
	Grade 6	587.21	117.65	21.85	542.46	631.96	
Word spelling	Grade 4	42.35	14.80	2.90	36.37	48.33	0.000
	Grade 5	56.15	8.93	1.72	52.62	59.68	
	Grade 6	60.48	10.77	2.00	56.39	64.58	
Word spelling time taken	Grade 4	1132.00	180.99	35.50	1058.90	1205.10	0.000 ^b
	Grade 5	777.85	121.60	23.40	729.75	825.96	
	Grade 6	670.62	76.892	14.28	641.37	699.87	

^ap-value generated by Kruskal-Wallis

^bp-value generated by Kruskal-Wallis

3 Results

Shapiro-Wilk normality test was conducted and to exercise caution, parametric tests (one-way ANOVA) were conducted with non-word spelling scores and the equivalent non-parametric test (Kruskal-Wallis H Test) was conducted with the atypically distributed samples.

Children obtained a higher mean score in word spelling (53.30) than non-word spelling (39.54). One-way ANOVA was used to compare mean word and non-word spelling scores and time-taken between the independent variables. Differences in time-taken to complete both the word and non-word spelling tests, among children who either speak Me, M/E, Em in the school setting were statistically significant because $p < 0.05$ (Table 3).

Grade 6 participants obtained higher mean scores in non-word spelling (42.59) than grade 5 (41.5) and grade 4 participants (34.46). The same pattern was observed in word spelling scores. Grade 4 students spent more time in non-word (854.04) and word spelling (1132.00) than grade 5 and 6 participants. Grade 6 participants spent the least time to complete the non-word spelling (587.21) and word spelling test (670.62). These differences in word and non-word spelling mean scores and time-taken were statistically significant because $p < 0.05$ (Table 2).

In addition to descriptive statistics, an analysis of spelling patterns was carried out. The tables below illustrate the spelling patterns that emerged in the administration of the Maltese Spelling Test (Aguis, 2012) (Table 5) and the non-word spelling test (Table 4).

Table 3. Comparison of mean scores and time-taken (grouped by school-language)

Subtest	Classroom Language	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		p-value
					Lower Bound	Upper Bound	
Non-word spelling	Mostly Maltese	39.36	11.34	1.66	36.03	42.69	0.839
	Mostly English	42.33	10.52	4.30	31.29	53.37	
	Maltese-English	39.24	13.28	2.47	34.19	44.29	
Non-word spelling time taken	Mostly Maltese	668.19	143.54	20.94	626.05	710.34	0.016a
	Mostly English	636.50	23.53	9.61	611.81	661.19	
	Maltese-English	803.07	209.03	38.815	723.56	882.58	
Word spelling	Mostly Maltese	54.96	13.28	1.94	51.06	58.86	0.432b
	Mostly English	55.17	7.055	2.88	47.76	62.57	
	Maltese-English	50.24	15.64	2.90	44.29	56.19	
Word spelling time taken	Mostly Maltese	814.40	239.87	34.99	743.98	884.83	0.033c
	Mostly English	779.00	217.34	88.73	550.92	1007.08	
	Maltese-English	928.66	220.24	40.90	844.88	1012.43	

^ap-value generated by Kruskal-Wallis

^bp-value generated by Kruskal-Wallis

^cp-value generated by Kruskal-Wallis

Table 4. Spelling patterns in Maltese non-word spelling

Spelling Pattern	Description	Example(s)
Spelling Patterns associated with the Lexical Route		
Orthographic Patterns · Patterns involving the <i>gh</i> and <i>h</i> · Additions of <i>gh</i> and <i>h</i> · Substitutions of <i>gh</i> and <i>h</i>	Patterns that involve the special Maltese graphemes <i>gh</i> and <i>h</i> .	<i>Nejġ - ngheġ</i> <i>Shul - sghul</i> <i>Għakx - qakx</i>
Phonetic Patterns	All the sounds in the word are present but spelled incorrectly.	<i>Died - diet</i>
Spelling Patterns indicating Sub-Lexical Route Failure		
Consonants: · Omissions · Substitutions · Additions	These errors involve consonants, including incorrect omissions, substitutions and additions.	<i>Nejġ - ngheġ</i> <i>Died - diet</i> <i>Rehba - qreba</i>
Vowels: · Omissions · Substitutions · Additions	These errors involve vowels, including incorrect omissions, substitutions and additions.	<i>Doppiwiet - doppiwet</i> <i>Vienel - vemel</i> <i>Knaqqarhulu - knauqarulu</i>
Metathesis	Switching the position of letters in a word.	<i>Qtieq - qiet</i>
Second Language Influence	Influences from other languages, mainly English. May include the use of foreign letters and orthography.	<i>Għakx - ghaksh</i> <i>Fapliki - phapliki</i>
Syllables: · Omissions · Additions	These errors involve syllables, and include deletions and additions of syllables.	<i>Kaffiċċieri - kaf</i> <i>Qtieq - buqtieq</i>
Geminate Reduction	Reducing two identical consonants (geminate pair) to one constituent consonant.	<i>Dalla - dala</i>
Duplication	Duplicating one consonant to form a geminate pair.	<i>Shul - sull</i>
Vowel Reduction	Reducing the long vowel [ie] to the short vowel [i].	<i>Ptiiek - pit</i>
Vowel Lengthening	Replacing the Maltese short vowel [i] with the long vowel [ie].	<i>Likar - liekar</i>
Spelling Patterns involving Morphological Components		
Morphological Patterns: · Omissions · Additions	These patterns include the spurious additions of morphemes and failure to recognize and include morphemes.	<i>L-(gh)ax - lash</i> <i>Kalloggħa - K'alloggħa</i>
Word Assimilation Errors (Campbell, 1983)		
Word Assimilation Errors	Writing the real word that resembles the non-word.	<i>Takiblar - katiedral</i>
Other Errors		
Errors involving Maltese Orthographic Conventions	This involves spelling errors of Maltese spelling conventions such as marking consonantal voicing in [ġ].	<i>Happus - happus</i>
Unrecognizable	Production of an unrelated word that does not resemble the stimulus item.	<i>Mintasadlek - dmatli</i>

Table 5. Spelling patterns in Maltese word spelling (Aguis, 2012)

Spelling Pattern	Description	Example(s)
Lexical Route Errors (Phonologically Plausible Errors)		
Orthographic Errors • Errors involving <i>gh</i> and <i>h</i> • Omission of <i>gh</i> and <i>h</i> • Substitution of <i>gh</i> and <i>h</i>	This group entails spelling errors involving the Maltese graphemes <i>gh</i> and <i>h</i> . These spelling patterns include substitutions and omissions of these graphemes.	<i>Leġġa</i> - <i>leġġa</i> <i>Leġġa</i> - <i>leġa</i> <i>Għanqbuta</i> (<i>web</i>)- <i>qabuta</i>
Phonetic Errors	Phonetic errors occur when all the sounds in the word are present but spelled incorrectly.	<i>Mewġ</i> (<i>waves</i>)- <i>mewċ</i> <i>Għatx</i> (<i>thirst</i>)- <i>ghaċ</i> ¹ <i>Nerġhu</i> (<i>repeat</i>)- <i>nerġaw</i>
Morphological Errors		
Spurious Additions of Morphemes	Incorrect inclusions of morphemes, for example articles and affixes, in a word.	<i>Qtigħ</i> (<i>cuts</i>)- <i>it-tieħ</i>
Omissions of Morphemes	The elimination of morphemes, including articles and affixes in a word.	<i>Minna</i> (<i>from her</i>)- <i>minna</i> <i>l- għažż</i> - <i>lghaž</i>
Sub-Lexical Route Errors		
Consonants: • Omissions • Substitutions • Additions	This group includes spelling errors of consonants, including incorrect omissions, substitutions and additions.	<i>Qaqoċċa</i> (<i>artichoke</i>)- <i>aoka</i> <i>Qaqoċċa</i> - <i>aoka</i> <i>l- għažż</i> (<i>laziness</i>)- <i>blažż</i>
Vowels: • Omissions • Substitutions • Additions	This group includes spelling errors of vowels, including incorrect omissions, substitutions and additions.	<i>Xoġhol</i> (<i>work</i>)- <i>xoġħl</i> <i>Tmaqdarhulu</i> (<i>she finds fault</i>)- <i>tmaqdarlu</i> <i>Qawwija</i> (<i>strong</i>)- <i>awwija</i>
Metathesis	This involves switching the position of vowels and consonants in a word.	<i>Kavaliġeri</i> (<i>knights</i>)- <i>kalaviri</i>
Second Language Influence	This includes influences from other languages, mainly English, in a word. This may involve the use of foreign letters and orthography.	<i>Skola</i> (<i>skola</i>)- <i>schoola</i>
Duplication	Duplicating an identical consonant/vowel.	<i>Qawwija</i> (<i>strong</i>)- <i>qawwijja</i>
Geminate Reduction	Reducing two identical consonants (geminate pair) to one constituent consonant only.	<i>Bajja</i> (<i>beach</i>)- <i>baja</i>
Vowel Reduction	Reducing the long vowel [ie] to the short vowel [i].	<i>Bottijiet</i> (<i>cans</i>)- <i>bottijit</i>
Vowel Lengthening	Replacing the Maltese short vowel [i] with the long vowel [ie].	<i>Qtigħ</i> (<i>cuts</i>)- <i>qtieġħ</i>
Syllables: • Omissions • Additions	This group includes spelling errors involving syllables, such as syllable omissions and additions.	<i>Nitkexkex</i> (<i>I feel goosebumps</i>)- <i>nitkex</i> <i>Gżejjer</i> (<i>islands</i>)- <i>ingzejjer</i>
Other Errors		
Omissions of Orthographic Conventions	This involves spelling errors of Maltese spelling conventions such as marking consonantal voicing in [ġ].	<i>Xoġhol</i> (<i>work</i>)- <i>xoġhol</i>

¹These two spelling errors can be classified as both lexical and sub-lexical errors because children require both a phoneme-grapheme correspondence approach (sub-lexical) and a whole-word approach (lexical) in order to apply the final devoicing rule.

The frequency of spelling patterns was also counted. Figure 1 illustrates the mean percentage occurrence of spelling patterns in the Maltese word spelling test. Geminate reduction was the most frequent spelling pattern in word spelling, while syllable additions were the least frequent.

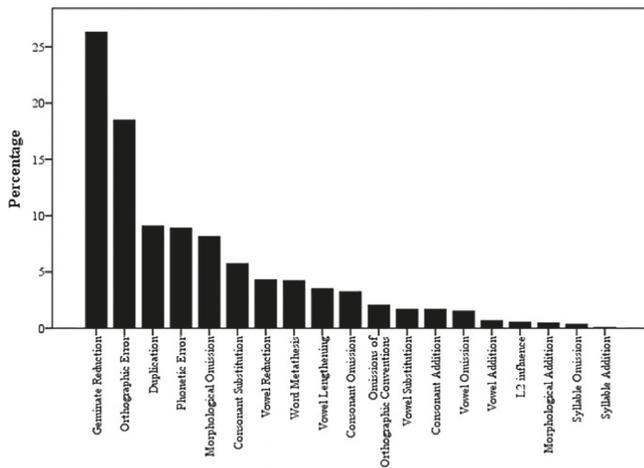


Figure 1. Spelling patterns in the Maltese word spelling (Agius, 2012)

Figure 2 illustrates the occurrences of spelling patterns in Maltese non-word spelling. Consonant substitutions were the most frequent spelling pattern while syllable additions were the least frequent spelling patterns observed in non-word spelling.

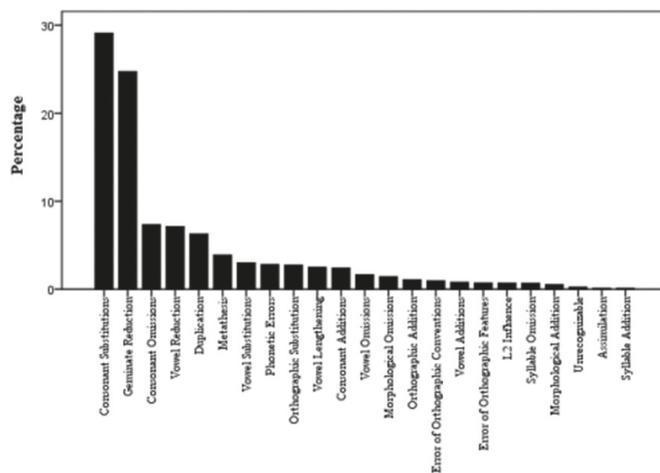


Figure 2. Frequency of spelling patterns observed in non-word spelling

4 Discussion

4.1 Performance in Maltese word and non-word spelling

Findings indicate that word and non-word spelling scores are significantly affected by grade. The time-taken to complete both tests is significantly affected by grade and school-

language. Children in grade 6 obtained better word and non-word spelling scores than grade 4 students. Agius (2012) also found that grade 6 students performed better than younger students in Maltese word spelling. Older students obtained better scores possibly because they have been exposed to the curriculum more than the younger cohort.

In all grades, children were more accurate in word spelling than non-word spelling. This may be explained in terms of a lexicality effect which was also reported by Notarnicola et al. (2012). This means that children tended to perform better in word spelling than non-word spelling. Sprenger-Charolles, Siegel, Bechennes and Serniclaes (2003) and Notarnicola et al. (2012) found that a ceiling effect in non-word spelling was present by the third grade. This ceiling effect is reached because sub-lexical approaches (supposedly used to spell non-words) develop early (Notarnicola et al., 2012). This study did not find a ceiling effect, which may indicate that children are using both lexical (supposedly utilized in spelling irregular words) and sub-lexical routes in the two spelling tests. Agius (2012) confirmed that both routes are applied in Maltese word spelling. Another possibility is that the newly developed non-word test was difficult for all the three grades.

Children in all three grades were faster to complete the non-word spelling test than the word-spelling test. Zevin and Seidenberg (2006) maintained that latency effects (time-taken) are produced by words with irregular grapheme-phoneme correspondences, which produce conflicts between the lexical and sub-lexical routes. The word-spelling test includes words with both regular and irregular phoneme-grapheme correspondences (because these contain digraph/graphemes *gh* and *h*). These graphemes could be omitted in the non-word spelling test. This finding indicates that irregular test-items in the word-spelling test may contribute to longer latencies.

The performance of school-language Maltese-dominant and Maltese-English bilingual participants in the word and non-word spelling tests was studied. School-language refers to the language spoken at school which is used for different purposes than home-language (Schleppegrell, 2004) and may eventually influence home language (Wang, 2008). Like Agius' (2012) findings, this study did not find statistically significant differences in word spelling scores. Post-hoc results revealed a significant difference between the bilingual and Maltese-dominant groups in the time-taken to complete the non-word spelling test only ($p = 0.003$). The bilingual group were slower to complete the non-word test. Agius (2012) explained that bilinguals possess and retrieve knowledge of two different codes (Maltese and English) and therefore require more time. De Sousa et al. (2011) also argued that bilinguals have busier cognitive loads because they are learning two languages. In this study, all participants were learning literacy in both languages but spelling was assessed in Maltese only. The distinction between the Maltese and English dominant and bilinguals' time-taken may be related to the effects of learning both L1 and L2 spelling and the busier cognitive loads that bilingual students have. Similar to Agius, the researcher did not find statistically significant differences in state and church schools' scores.

4.2 What spelling patterns associated with sub-lexical and lexical processing in the dual-route model? What do these spelling patterns indicate about the participants' knowledge of Maltese orthography?

Spelling patterns in the Maltese word-spelling test were grouped into four distinctive categories. The first category was characterized by *lexical route failure*. The first group in this category involved the Maltese special orthographic features, the *gh* and *h*. These spelling patterns indicate *lexical route failure* because this route accesses phonological memory representations and word-specific orthographic features in spelling. The sub-lexical route, which activates sound-spelling correspondences (Rapcsak, Henry, & Beeson, 2007), cannot be utilized in spelling words involving these graphemes because *gh* and *h* are silent except in word final positions (Hoberman, 2007). Notarnicola et al. (2012) also classified ambiguous spellings under this category in Italian. When the sub-lexical route was utilized to spell ambiguous words (words dependent on context-sensitive rules and have indirect phoneme-grapheme correspondences), phonologically plausible errors were produced. This implies that the produced words still possessed correct phoneme-to-grapheme conversions (indicating sub-lexical processing) but the letters are incorrect therefore indicating lexical route failure. De Sousa et al. (2011) also analyzed spelling patterns in English and argued that since English has an irregular phoneme-to-grapheme correspondence; lexical spelling would need to be utilized.

Spelling patterns involving *gh* and *h* resulted in confusions, for example *lehġa* was written as *legħġa*. Omissions and substitutions were also present, for example *għanqbuta* (*web*) was written as *qanqbuta*. In these instances, participants produced phonologically plausible errors and this is evidence of lexical route failure. The occurrence of these spelling errors was only significant when grade was factored in ($p = 0.14$). Post-hoc analysis revealed that 5th graders presented these spelling patterns more than the other grades did. This shows that this particular cohort continued to experience difficulties with these graphemes until later grades and may be the result of new rules introduced in this grade having a negative impact. Agius (2012) also found that as a result of difficulties with *gh* and *h*, Maltese students' spelling abilities are low in the grade 4 to 6 student population.

The second category associated with lexical route failure is called *phonetic errors*. According to Goulandris (2003) phonetic spelling occurs when the correct sounds in a word are denoted with the incorrect use of letters (e.g. *cool- cule*). Maltese makes a distinction between automatic phonological processes like final consonant devoicing and their representations in orthography. For example, the word *ħobż* (*bread*), which orthographically ends with the voiced consonant *ż*, ends with the unvoiced consonant /ħɔps/ when pronounced. This phenomenon was a source of spelling errors because participants spelled the word phonologically (used the unvoiced consonant). A technique can be used, in which spellers derive a related word to determine if the

last consonant is voiced or unvoiced (A. Borg, personal communication, February 14, 2014), to avoid these spelling patterns. This study did not obtain information about whether these techniques are taught in the curriculum to facilitate Maltese spelling. A statistically significant difference in the occurrences of phonetic errors was not found.

The third category of spelling errors involved *omissions and additions of morphemes*. Potopapas et al. (2013) found evidence of morphological errors in Greek. These spelling patterns were expected because Maltese has a productive morphology, meaning that the predominantly Arabic morphology can be attached to any word of Romance and English origin (Hoberman & Aronoff, 2003). A morphological spelling pattern was seen with the word *l-ghażż* (*the laziness*). The article was frequently omitted from this word. The article, *l-*, expresses definiteness in Maltese (Borg & Azzopardi-Alexander, 1997). The researcher found statistical significance for morphological omissions when comparing these among the three grades only ($p = 0.006$). Grade 5 students presented morphological omissions more commonly than the other grades. Lehtonen and Bryant (2005) argued that spellers must understand spelling rules based on morphology since following phoneme-grapheme correspondences is not enough. This study found that Maltese participants continued to experience difficulties with morphological representations in later years.

The third category of spelling patterns included spelling patterns characterizing sub-lexical route failure. This means that spelling patterns occurred as a result of incorrect phoneme grapheme correspondences (Houghton & Zorzi, 2003), giving rise to consonant, vowel and syllable omissions, additions and substitutions, metathesis, L2 influences, duplications and geminate reductions, vowel lengthening and reductions. Notarnicola et al. (2012) argued that development of the sub-lexical route should occur earlier on. In fact, stage theories (e.g. Gentry, 1982; Ehri, 1986) of development included phoneme-grapheme conversion in their theories. Difference in occurrences was only found for vowel reduction ($p = 0.004$), consonant omissions ($p = 0.001$) and L2 influences ($p = 0.20$) across grades.

Grade 4 participants presented more spelling patterns influenced by English (the L2 in Malta). For example *skola* (*school*) was written as *schoola* and *fabbriki* (*factories*) was written as *phabbriki*. Spelling patterns that indicate L2 influences are evidence of sub-lexical failure because Maltese graphemes are written with their IPA value. Therefore, L2 influences indicate failure to use direct phoneme-grapheme conversion. These findings indicate that although sub-lexical route use in spelling should occur earlier in development (Notarnicola et al., 2012), Maltese students continue to present sub-lexical route failure due to L2 influences by the end of primary school even though English literacy is introduced early in Grade 1 in Malta (Ministry for Education and Employment, 2014). The last category of spelling patterns is termed *others*. This category involved Maltese orthographic conventions, for example omitting indications of voiced consonants (for example, the *dot* marking voicing in *ġ* and *ż*). Occurrences of these spelling patterns were not statistically significant.

4.3 Spelling patterns in non-word spelling

Bates et al. (2007) claimed that non-words and words with direct sound-letter correspondences activate the sub-lexical route. However, Tainturier & Rapp (2001) claimed that both lexical and sub-lexical routes interact in spelling. A non-word spelling test can be utilized to assess the sub-lexical route because knowledge of sound-letter conversions is necessary. Despite this, spelling non-words is not exclusively associated with the sub-lexical route. For example, Campbell (1983) found that non-words spellings were compared to real word prime words. This indicates that spellers may model non-word spellings on real word spelling.

The first category of non-word spelling patterns involved additions and substitutions of the Maltese graphemes, *gh* and *h*. These graphemes were marked as optional in the non-word spelling test and participants were not penalized if they did not include them. Spelling patterns were only counted if the wrong grapheme was used or substituted with a consonant. Substitutions of these graphemes in non-words were statistically significant across grades ($p = .10$). Grade 5 students frequently substituted these graphemes with other consonants. This finding shows that participants cannot represent these graphemes consistently in non-word spelling. Spelling patterns involving additions of these graphemes were interesting. For example, the grapheme *gh* was often added to the test-item *nejġ*. The grapheme *gh* can lengthen adjacent vowels (Hoberman, 2007) and this example may indicate that participants compared non-word test-items to real words. In fact, during administration participants could identify the real word that the non-word was based on. This shows that like Campbell's (1983), and Martin and Barry's (2012) research some degree of priming may have occurred.

Another class of spelling patterns in non-word spelling was referred to as *phonetic errors*. These patterns were highly associated with the final consonant devoicing process in Maltese. Therefore, non-words that ended with a voiced consonant were represented orthographically with the unvoiced consonant. For example, the non-word *ġlaled* was written *ġlalet*. The pronunciation of the word itself could not avoid this phonological process and therefore participants used the sub-lexical route to spell these words. This may indicate that participants did not acknowledge this distinction between Maltese phonology and orthography. Such instances were considered as a spelling pattern in this research, however non-word spelling should reflect direct sound-to-letter correspondences and should be more flexible in allowing the participants' interpretation of the language's orthography. This will be considered in future studies. This spelling pattern was not statistically significant.

The majority of spelling patterns in non-word spelling exhibited *sub-lexical route failure*. This gave rise to consonant, vowel, and syllables omissions, additions and substitutions, metathesis and L2 influences, vowel lengthening and reduction, geminate reduction and duplication. There were no statistically significant differences in the occurrences of these spelling patterns among all the independent variables. Nonetheless, these patterns were characterized as sub-lexical route failure because they exhibited incorrect phoneme to

grapheme conversions. Stage theories of development and Notarnicola et al. (2012) claim that sub-lexical processing should occur earlier on in spelling development. In contrast, these findings indicate that with regards to this specific population, Maltese students continue to experience difficulties with phoneme-to-grapheme correspondences.

The third category involved *morphological components*. Differences in the occurrences of morphological components were statistically significant across the three grades ($p = 0.006$). The non-word spelling test involved the use of articles, which were often not recognized by the participants. These spelling patterns are not necessarily incorrect because these reflect sound to letter conversions of the participants (sub-lexical processing). Nonetheless, Lehtonen and Bryant (2005) found that beginner Finnish spellers parsed segments that represented morphemes in non-words and did not interpret non-words as a whole. Participants also added morphemes to non-words in this study, in particular articles and clitics for example *kalloġġa* was written as *k'alloġġa*. The prepositions *fi* (in) and *bi* (with) can cliticize to a noun (Borg & Azzopardi-Alexander, 1997). This example in the non-word spelling test is similar to this Maltese occurrence although the clitic *k'* does not exist. However, this may indicate that participants are modelling non-word spellings to real words and morphological components (real word priming). This occurrence was not statistically significant. The last class of spelling patterns involved assimilation of non-words to real words, failure to recognize orthographic conventions and other unrecognizable errors. Non-word assimilation indicates comparisons to real words (Campbell, 1983). Unrecognizable patterns are equivalent to Snowling's (1987) *non-phonetic errors*.

5 Conclusion

Maltese word and non-word spelling skills of children attending state and church schools are significantly affected by grade. School language was found to significantly affect spelling rate. This research also uncovered a lexicality effect, in which word spelling scores are better than non-word spelling scores. All grades (grades 4 to 6) also experienced notable difficulties with sub-lexical phoneme-grapheme conversions and *gh* and *h*. Statistical significance was particularly marked for grade 5 students. Moreover, Maltese word spelling patterns can be classified under four distinctive categories, indicating lexical and sub-lexical routes failure, difficulties with morphological components and other errors related to Maltese orthography. An additional category, *assimilation*, was found in non-word spelling.

Limitations to this study include the omission of the third school type in Malta, independent schools, because this school type tends to emphasize spoken English. This research was interested in the assessment of monolingual Maltese (Me) and bilingual Maltese-English children (M/E), therefore independent school children were not included. Research findings therefore can only be generalized to this specific population. The non-word spelling test generated a low Cronbach's alpha, which may indicate inconsistency in deriving the same scores.

This research is the first of its kind to explore processes in Maltese students' word and non-word spelling in relation to their spoken language. The study's findings can inform practitioners such as language teachers and Speech-Language Pathologists about students' typical and atypical spelling patterns, knowledge of sound-letter conversions and processing time. Future research aims to address permissible non-word spelling patterns that reflect students' phoneme-grapheme conversions and to increase the reliability of the non-word spelling test. This research would include and compare English and Maltese word and non-word spelling abilities to investigate transfer effects and error types in both languages.

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8 Conflicts of interest

The authors report no conflicts of interest.

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Footnotes

- 1 These two spelling errors can be classified as both lexical and sub-lexical errors because children require both a phoneme-grapheme correspondence approach (sub-lexical) and a whole-word approach (lexical) in order to apply the final devoicing rule.